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THE SYSTEMATIC ANATOMY OF SOUTH INDIAN *CYPERACEÆ* : *ELEOCHARIS* R. Br., *RHYNCHOSPORA* Vahl AND *SCLERIA* Bergius

by E. GOVINDARAJALU

SUMMARY: The eight investigated species of *Eleocharis* may be primarily divided into three groups depending on the number and nature of the bundle sheaths; and further anatomical distinction can be based on the type of sclerenchyma, the number of vascular bundles and their arrangement, and the type of tissue in the air-cavities. Two groups of species are recognized in *Rhynchospora* based on the nature of bulliform cells, and these are further distinguished by the type of sclerenchyma strand, presence or absence of hypodermal translucent cells, number of vascular bundles and nature of bundle sheaths. The occurrence of one or more than one type of silica- bodies in the leaf epidermis of *Scleria*, as well as other leaf characters, favours the grouping of the eleven taxa into two categories. Keys based on anatomy are given for each genus.

INTRODUCTION

Out of eight south Indian species of *Eleocharis*, PALLA (1888-99) examined only the culm anatomy of *E. atropurpurea*, *E. capitata*, *E. fistulosa*, *E. plantaginea* and *E. spiralis*. HESS (1953) also examined the culm of *E. atropurpurea* and *E. dulcis* (= *E. plantaginea*) and METCALFE (1971) that of *E. acutangula*, *E. geniculata* and also the root anatomy of the latter. PFEIFFER (1927) studied the leaf (scale leaf or sheath?) of *E. capitata*. However, the only species for which the vegetative anatomy is completely known is that of *E. dulcis* (under *E. plantaginea*) (SCHILLING, 1918; MEHRA & SHARMA, 1963). MEHRA & SHARMA (1965) reported the characteristics of silica cells in *E. atropurpurea*, *E. palustris* and *E. plantaginea*. Thus it may be observed that the anatomical information that is available at present is incomplete with respect to the south Indian taxa and the present work provides a comparative anatomical information of all the eight species.

Barring the availability of complete anatomical information for *Rhynchospora corymbosa* (leaf, culm, rhizome and root) and *R. rugosa* (leaf and culm), for the rest of south Indian species it is far from complete and satisfactory. This points to the need for a more comprehensive investigation of the comparative anatomy of south Indian species of *Rhynchospora* as a contribution towards our knowledge of the genus as a whole. As I have already completed detailed studies of occurrence and distribution of the atypical, non conical silica-bodies that occur in the

five south Indian species of this genus (GOVINDARAJALU, 1969), I have avoided repetition by referring only to typical cone shaped silica-bodies in the present communication.

The anatomy of south Indian species of *Scleria* is little known. KOYAMA (1967) studied only the leaf anatomy of *Scleria caricina* (R. Br.) Benth. (= *Diplacrum caricinum* R. Br.), *S. levis*, *S. lithosperma*, *S. sumatrensis* and *S. terrestris*. Recently METCALFE (1971) has described the anatomy of the leaf and culm of *S. sumatrensis* and that of culm only of *S. tessellata*. The occurrence of calcium oxalate crystals has been reported in the leaf and culm epidermis of *S. tessellata* (MEHRA & SHARMA, 1965). METCALFE (1969) has furnished a synopsis of anatomical information pertaining to the type of silica-bodies, chlorenchyma, bundle sheaths of the tribe *Scleriæ* as a whole followed by certain general comments. In view of the fact that no cogent anatomical information is available for all the eleven south Indian taxa, the present study is undertaken towards this end.

MATERIAL AND METHODS

The specimens used in this investigation are mostly from the collections deposited in the Herbarium of the Presidency College, Madras and cited as PCM and partly from the herbarium of the Botanical Survey of India, Coimbatore and cited as MH. Besides the dried herbarium materials, pickled materials of a few species corresponding to the herbarium numbers were also used. The list of the specimens together with collection localities are given at the end of the description of each species. To avoid repetition in the citation of individual specimens, the first two letters of the collector's name are given (e.g. *Go* = *Govindarajalu*).

Methods are the same as those that have been followed in previous works (GOVINDARAJALU, 1966; 1968 *a*, *b*; 1969). The designation of the type of vascular bundles and metaphloem is after CHEADLE & UHL (1948 *a*, *b*). Most descriptive terms are those that have been proposed by METCALFE & GREGORY (1964). The common characters that have already been reported by METCALFE (1971) are indicated as (MET.).

I. CHARACTERS COMMON TO EACH GENUS

Eleocharis

1. Each silica-cell either containing large non conical silica-bodies or few to many smaller conical silica-bodies except in the sheaths of *E. spiralis* (Pl. 2, F; 4, G).
2. Stomata paracytic, having either parallel-sided or low dome-shaped subsidiary cells (Pl. 4, C, D), but generally doming a bit more prominent (MET.); interstomatal cells long or short with straight or concave ends.
3. Air-cavities present in culms and sheaths, each traversed by diaphragm of lobed or stellate parenchyme (Pl. 2, E; 4, E, F, I) (MET.).
4. Larger culm vb's belonging to type III B (Pl. 1, E).
5. Root cortex lacunose occurring as few to several concentrically arranged air-cavities separated by radiating rows of connecting cells (Pl. 1, F; 2, A, D) (MET.).

Rhynchospora

1. Stomata paracytic (Pl. 6, B); interstomatal cells with concave ends; substomatal chambers narrow and small (Pl. 5, K).
2. Silica-cells in leaves occurring always in uninterrupted rows.
3. Cuticle thick in leaves and culms (Pl. 5, A; 6, C, F; 7, A).
4. Adaxial epidermal cells larger than those of the abaxial (Pl. 6, C, D) (MET.).
5. Vascular bundles in leaves are of two different sizes (Pl. 5, A; 6, C; 7, D) (MET.).
6. Bundle sheaths of laminal vb's double, O.S. parenchymatous, I.S. sclerenchymatous (Pl. 7, B) (MET.).
7. Metaphloem in leaves, sheaths, culms and inflorescence axis belongs to " regular type ".
8. Vascular bundles in leaves and culms belonging to types I (Pl. 7, B) and III B.

Scleria

1. Cuticle usually thick in leaves, culms and sheaths (Pl. 8, G, L; 9, A, C, F; 10, A, F, I, etc.).
2. Adaxial epidermal cells larger than those of the abaxial (MET.).
3. Stomata paracytic in every organ (Pl. 8, Q); interstomatal cells with concave ends but straight only in *S. caricina* and *S. lithosperma* var. *muricata*.
4. Mesophyll consisting of 1-2 adaxial layers of palisade (MET.) and few to several layers of spongy parenchyma.
5. Leaf vb's possessing double sheaths, O.S. parenchymatous and I.S. sclerenchymatous (MET.); bundle sheath single layered, sclerenchymatous only in *S. lithosperma* var. *muricata* and *S. tessellata*.
6. Outline of leaf in T.S. inversely ' W ' shaped (Pl. 8, E) (MET.); shallowly corrugate in *S. sumatrensis* (Pl. 8, K).
7. Leaves containing vb's of 2-3 different sizes (Pl. 8, A, C, G, L); large and medium size bundles belonging to type III A and smaller bundles to type I excepting those of *S. terrestris* and *S. lithosperma* var. *multispiculata* in which large bundles belonging to type III B and medium bundles to type III A.
8. Culms possessing a peripheral ring of vb's (Pl. 9, A, B, C; 10, A, H, I, J, K).
9. Metaphloem in leaves and culms belonging to " regular type "; that of *S. lithosperma* var. *muricata* in the leaves being " irregular type " and that of *S. caricina* and *S. sumatrensis* in culms belonging to " intermediate type ".
10. Rhizomes consisting of outer and inner zones; vb's of type V; metaphloem of " irregular type "; central ground tissue parenchymatous; circumvascular sclerenchyma complete.

11. Roots containing inner and outer cortex; inner consisting of concentrically arranged air-cavities separated by radiating rows of parenchyma cells.
12. Tannin idioblasts common, abundant or very abundant (Pl. 8, A, G, L; 9, A, B, F; 10, H, J, K).

II. DESCRIPTIONS OF INDIVIDUAL SPECIES

ELEOCHARIS

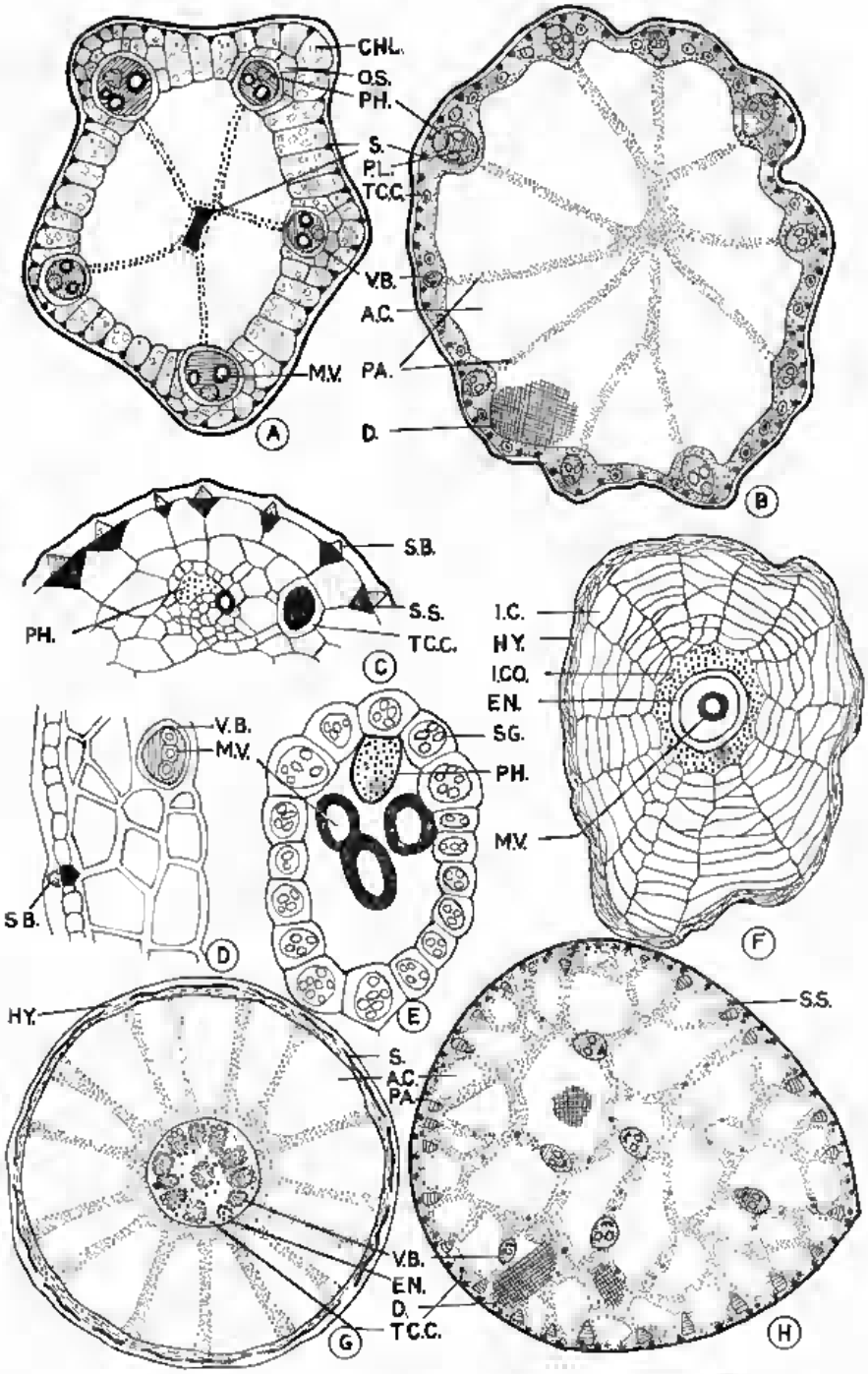
Eleocharis acutangula (Roxb.) Schultes (*E. fistulosa* Schultes)

SHEATH. *Abaxial surface :* Epidermal cells hexagonal with smooth thin walls. Stomata (L. 72 μ; W. 16 μ) very narrow, elongated; subsidiary cells very narrow, parallel sided; interstomatal cells axially elongated with concave ends. Silica-cells narrow, thin-walled, axially elongated, occurring in 1-2 continuous rows, each cell containing 8-12 large cone shaped silica-bodies and intermixed with several indiscriminately arranged smaller bodies.

Transverse section: Epidermal cells relatively small and thick-walled contrasting abruptly with the much larger cells of the ground tissue. Sclerenchyma strands (Ht. and W. 12-16 μ) consisting of 4-6 cells, many, usually pentangular (Pl. 1, D). Vb's 20-25 belonging to type III B. Bundle sheaths single, parenchymatous, complete. Metaphloem of " regular type " having each sieve tube element regularly associated with one companion cell. Tannin idioblasts rare.

CULM. *Epidermis, surface view :* Cells axially elongated, somewhat broad, lateral walls sinuous, thin, end walls straight. Stomata, see sheath. Silica-cells overlying the peripheral sclerenchyma strands, see sheath.

Transverse section: Outline broadly ovate (Pl. 1, H). Diameter of the culm examined 1.7 mm. Epidermal cells relatively small and thick-walled contrasting abruptly with the hypodermis consisting of 2-4 layers of much larger parenchymatous cells. Air-cavities many, variable in size and shape, each traversed by diaphragms of thick-walled stellate parenchyma interspersed with trilobed or triangular spaces (Pl. 4, E); air-cavities separated from one another by a single row of cells. Vb's 34 arranged in peripheral and central systems and the bundles in each being of two distinct sizes, the smaller of which is shown in Pl. 1, E; peripheral bundles in a ring of 28; central bundles (6) scattered. Bundle sheaths single, parenchymatous, complete, cells containing starch grains (Pl. 1, E). Circumvascular sclerenchyma of larger bundles 3-5-layered, comprising inner caps. Sclerenchyma strands and metaphloem, see sheath. Tannin idioblasts abundant.



Pl. 1. — **Eleocharis retroflexa** : A, T. S. culm, ground plan (× 170). — **E. congesta** : B, T. S. culm, ground plan (× 60). — **E. retroflexa** : C, T. S. sheath (*pro parte*, × 300). — **E. acutangula** : D, T. S. sheath (*pro parte*, × 450). — E, **acutangula** : E, T. S. culm vascular bundle (× 350). — F,E. **congesta** : F, T. S. root, ground plan (× 75). — **E. acutangula** : G, T. S. stolon, ground plan (× 30). — **E. acutangula** : H, T. S. culm, ground plan (× 30).

STOLON. *Transverse section :* Outline circular (Pl. 1, G); diameter of stolon examined 1.7 mm. Epidermal cells thick-walled. Hypodermis consisting of 1-2 layers of sclerenchymatous cells in discontinuous bands. Outer cortex 2-3 cells thick, the parenchymatous cells contrasting abruptly with those of the hypodermis because of their larger size; middle cortex lacunose containing radially arranged air-cavities each separated from the next by a single row of radiating parenchyma cells; inner cortex composed of a single layer of parenchyme. Endodermis prominent; cells with moderately and uniformly thickened cell walls. Pericycle consisting of thick-walled cells. Vb's 12 in number and belonging to type V, 11 of them forming a ring with one bundle in the centre. Metaphloem, see sheath. Central ground tissue sclerenchymatous. Silica-bodies present in cells overlying the peripheral sclerenchyma strands. Tannin idioblasts common. Starch grains absent.

ROOT. *Transverse section :* Outline more or less circular (Pl. 2, A); diameter of the root examined 0.9 mm. Epidermis: cells thick-walled, suberized. Hypodermis parenchymatous, 1-layered. Outer cortex with concentrically arranged air-cavities, those along consecutive radii separated from one another by radiating rows of parenchymatous cells. Inner cortex 2-3-layered, cells compactly arranged and parenchymatous (Pl. 2, A). Endodermis prominent; cells with - U - shaped thickening and broad lumina. Pericycle conspicuous. Large metaxylem elements 4 with as many protoxylem units. Vessel members (D. 30-36 μ in diameter). Metaphloem not easily distinguishable. Ground tissue sclerenchymatous.

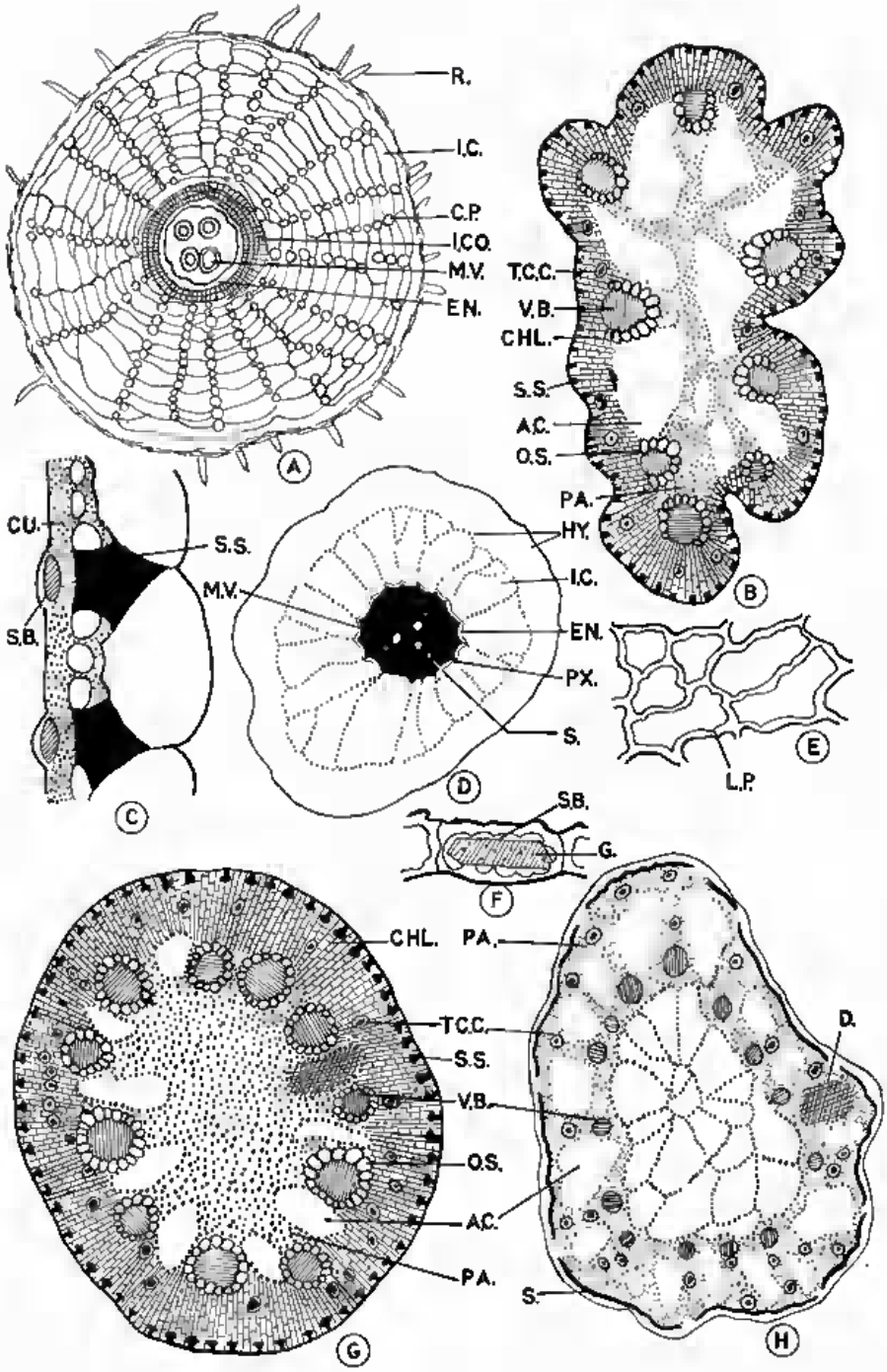
MATERIALS EXAMINED: Kambakkam, Nellore Dt. *Govindarajalu 8016.*

Eleocharis atropurpurea (Retz.) Kunth

SHEATH. *Abaxial surface:* Epidermal cells axially elongated, narrow, lateral walls thin and smooth, end walls straight. Stomata (L. 44 μ; W. 16 μ) long, narrow; subsidiary cells parallel-sided; interstomatal cells axially elongated, narrow with straight end walls as in the culm of *E. retroflexa* (Pl. 4, C). Silica-cells elongated, narrow, occurring in single continuous files, each cell containing 10-17 larger cone-shaped silica-bodies and several smaller scattered ones.

Transverse section: Epidermal cells thin-walled, contrasting abruptly with the much larger parenchymatous cells of the ground tissue. Sclerenchyma (Ht. & W. 12-16 μ) 4-6-celled, usually pentangular as in *E. acutangula* (Pl. 1, D). Vb's 20-25, belonging to type III B. Bundle sheaths single, parenchymatous, complete. Metaphloem of "regular type". Tannin idioblasts not common.

CULM. *Epidermis, surface view :* For epidermal cells, silica-cells (overlying peripheral sclerenchyma strands), see sheath. Stomata (L. 44 μ; W. 20 μ) together with accompanying subsidiary and interstomatal cells, see sheath.



Pl. 2. — **E. acutangula** : **A**, T. S. root, ground plan (× 68). — **E. atropurpurea** : **B**, T. S. culm, ground plan (× 83); **D**, T. S. root, ground plan (× 125). — **E. spiralis** : **C**, T. S. sheath epidermis (× 490); **H**, T. S. stolon, ground plan (× 14). — **E. geniculata** : **E**, Diaphragm cells, surface view (× 490); **F**, Culm epidermal cells, surface view (× 490); **G**, T. S. culm, ground plan (× 68).

Transverse section: Outline irregular (Pl. 2, B). Epidermis bounded on the inner side by 3-4 layers of palisade chlorenchyma. Peripheral sclerenchyma strands (Ht. 16-20 μ; W. 16 μ) pentangular, alternating with groups of 2-3 epidermal cells. Ground tissue lacunose with air-cavities of variable size and shape alternating with vb's; each air-cavity separated from the next by 1-2 rows of parenchyma cells. Air-cavities traversed at intervals by diaphragms of lobed, thick-walled parenchyma cells as in *E. geniculata* (Pl. 2, E). Vb's about 8 or 9 arranged in a regular ring. Bundle sheaths double; O.S. parenchymatous, incomplete; I.S. sclerenchymatous, complete. Vessel members (D. 16-20 μ in diameter). Metaphloem as in sheath. Tannin idioblasts common in the hypodermis.

ROOT. *Transverse section:* Outline subcircular (Pl. 2, D), diameter of the root examined 0.4 mm. Exodermis: cells in 2-3 layers; walls suberized. Hypodermis sclerenchymatous, 1-layered. Cortex lacunose including radially arranged air-cavities, each separated from the next in a contiguous sector by a radiating row of connecting cells. Endodermis prominent, consisting of cells with 'U' shaped thickenings and elliptical lumina. Large metaxylem elements 3 associated with as many protoxylem units. Vessel members (D. 16 μ in diameter). Metaphloem scarcely distinguishable. Central ground tissue sclerenchymatous.

MATERIAL EXAMINED: Gingee, N. Arcot Dt., *Govindarajalu 5430;* Nalur, Mysore state, *Go. 5208;* Ennore, Madras state, *Go. 5600;* Vedanthangal, Chinglepet Dt., *Go. 5718;* Ernavur, Madras state, *Go. 6379, 6380;* Arappakkam, N. Arcot Dt., *Subramaniam 6927.*

Eleocharis congesta D. Don

SHEATH. *Abaxial surface:* Epidermal cells almost isodiametric, thin-walled, with smooth lateral and straight end walls. Cone shaped silica-bodies present in the corners of the anticlinal walls (Pl. 3, H). Stomata (L. 44 μ; W. 28 μ); interstomatal cells short with concave ends as in the culm. Silica-cells long, narrow, thin-walled, occurring in 1-2 continuous files, each cell containing several smaller and larger cone shaped silica-bodies.

Transverse section: Epidermal cells thin-walled. Cuticle very thick. Ground tissue consisting of 2-3 layers of large parenchyma cells. Sclerenchyma strands (Ht. & W. 8-12 μ), many, few-celled, pentangular. Vb's 13-17 in number of type III B. Bundle sheath single, sclerenchymatous, complete. Metaphloem of "intermediate type". Tannin idioblasts not common.

CULM. *Epidermis, surface view:* Cells axially elongated, narrow; lateral walls thin, moderately sinuous and end walls concave. Stomata (L. 40 μ; W. 24-28 μ), see sheath (Pl. 3, D). Silica-cells overlying the peripheral sclerenchyma strands axially elongated, narrow, thin-walled,

occurring in 1-2 continuous files, each cell containing (3-) 4-5 (-6) large cones-haped silica-bodies and several smaller bodies arranged more or less in the form of satellites.

Transverse section: Outline circular but lobed (Pl. 1, B). Diameter of the culm examined 0.24 mm. Epidermal cells large, thin-walled, followed by 3-4 layers of palisade chlorenchyma. Centre lacunose with 10 unequally divided air-cavities; each cavity radially separated from the next by 2-4 rows of parenchyma cells. Air-cavities traversed by diaphragms of thick-walled stellate parenchyma cells interrupted by triangular to elliptical intercellular spaces between them as in *E. dulcis* (Pl. 4, I). Vb's 10 in number, comprising larger and smaller bundles forming a peripheral ring (see sheath). For sclerenchyma strands and tannin idioblasts, see sheath.

ROOT. *Transverse section:* Outline subcircular (Pl. 1, F); diameter of the root examined 0.6 mm. Epidermal cells moderately thick-walled. Cortex including tangentially stretched concentrically arranged intercellular air-cavities, those along contiguous radii separated by rows of parenchymatous cells; innermost cortex sclerenchymatous, 2-layered. Endodermis prominent; cells with uniformly thickened walls and oval to triangular lumina. Xylem with a solitary, central metaxylem elements. Vessel members (D. 48 μ in diameter). Protoxylem units 10. Metaphloem not easily recognizable.

MATERIAL EXAMINED: Machurpath, *Bourne 1424; sine loco, Fyson 6330;* Ooty, *FY. 2889;* Ooty, *Lakshmi 15;* Naduvattam, Ooty, *Nirmala Maharaj 393;* Thekkadi, Kerala state, *Sivachidambaram 145;* Yercaud, Salem Dt., *Vasanth Singh 7037.*

Eleocharis dulcis (Burm. f.) Henschel (*E. plantaginea* (Retz.) R. & S.)

SHEATH. *Abaxial surface:* Epidermal cells axially elongated, narrow, moderately thick-walled, lateral walls sinuous; end walls straight, oblique or overlapping. Stomata not observed. Silica-cells axially elongated, narrow, thin-walled, occurring in 1-2 continuous files, each cells containing 6-8 large cone-shaped silica-bodies intermixed with indiscriminately arranges smaller bodies.

Transverse section: Epidermal cells very small, thick-walled; epidermis interrupted by sclerenchyma strands, internally bounded by 2-3 layers of palisade chlorenchyma. Sclerenchyma strands (Ht. & W. 16-20 μ) inversely securiform as in the culms of *E. geniculata* (Pl. 2, G). Air-cavities many, arranged in a ring and regularly alternating with vb's; air-cavities traversed by diaphragms of stellate parenchyma interspersed by triangular to oval intercellular spaces. Vb's 42 in number belonging to type III B. Bundle sheaths single, incomplete, comprising very large sclerenchyma cells; circumvascular sclerenchyma 2-3-layered, crescentiform forming inner caps. Metaphloem of "regular type". Tannin and starch grains not seen.

CULM. *Epidermis, surface view:* Cells axially elongated, narrow, moderately thick-walled; lateral walls conspicuously sinuous, end walls straight. Stomata (L. 44 μ; W. 16 μ), elongated, very narrow; subsidiary cells parallel-sided; interstomatal cells elongated withc oncave ends. Silica-cells overlying the peripheral sclerenchyma strands arranged in single continuous files, all silica-cells containing 2-4 larger cone shaped silica-bodies and few smaller ones.

Transverse section: Outline circular with numerous low ribs and furrows (Pl. 4, J); diameter of the culm examined 2.6 mm. Epidermal cells small, thick-walled. 1-2 layers of enlarged parenchyma cells present internally next to epidermis. Air-cavities 30, regularly alternating with

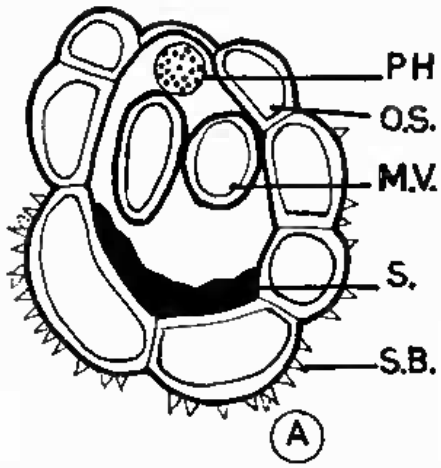


Fig. 3. — **E. dulcis** : A, T. S. vascular bundle (× 300).

vb's and each one radially delimited by a single row of parenchyma cells; air-cavities traversed by diaphragms of cells similar to the corresponding cells in *E. congesta.* Sclerenchyma strands (Ht. & W. 20-24 μ), many, varying from triangular to pentangular, regularly alternating with groups of 2-3 epidermal cells. Vb's consisting of an outer ring of 30 and an inner ring also of 30 bundles and regularly alternating with those of the outer ring. For bundle sheaths, circumvascular sclerenchyma and metaphloem, see sheath; bundle sheath cell walls silicified with cone-shaped silica-bodies (Fig. 3, A). Centre hollow but traversed by diaphragms at regular intervals. Diaphragm cells stellate with thick, pitted walls and interspersed by triangular intercellular spaces (Pl. 4, I). Tannin idioblasts and starch grains not seen.

ROOT. *Transverse section:* Diameter of the root examined 1.2 mm. Large metaxylem elements 5, central, arranged in a stellate manner. Protoxylem units 5. Vessel members (D. 48 μ in diameter). For other details, see *E. acutangula.*

MATERIAL EXAMINED: Mahabalipuram, Chinglepet Dt., *Govindarajalu 5932;* Sriperumpudur, Chinglepet Dt., *Go. 6345;* Ennore, Madras, *Go. 6424;* Munner, Madurai Dt., *Jagannathan 13.*

Eleocharis geniculata (L.) Roem. & Schult. (*E. capitata* R. Br.)

SHEATH. *Abaxial surface:* Epidermal cells axially elongated, narrow, moderately thick-walled, lateral walls sinuous, end walls straight. Stomata not seen. Silica-cells moderately long and narrow with thick sinuous lateral walls. Cells occurring in 3-6 continuous files, each containing 4-6 larger cone-shaped silica-bodies associated with few smaller scattered bodies.

Transverse section: Epidermal cells thick-walled. Ground tissue parenchymatous, up to 8-layered in winged lateral parts. Sclerenchyma strands (Ht. 28 μ; W. 40 μ) triangular to rectangular. Vb's 5 in number belonging to type I. Bundle sheaths single, sclerenchymatous, complete. Metaphloem of " irregular type ". Tannin idioblasts and starch grains not seen.

CULM. *Epidermis, surface view:* Cells, see sheath. Long cells intermixed with short cells, the latter containing elongated silica-bodies with denser granules (Pl. 2, F). Stomata (L. 48 μ; W. 24 μ) similar to those of *E. retroflexa* (Pl. 4, C); interstomatal cells short with concave ends. Silica-cells occurring in 1-2 continuous files, see sheath.

Transverse section: Outline subcircular as in Pl. 2, G. Diameter of the specimen examined 0.85 mm. Epidermis internally followed by 3-4 layers of palisade chlorenchyma. Air-cavities 9 in number, variable in size and shape and regularly alternating with vb's (Pl. 2, G). Air-cavities traversed by diaphragms of lobed, thick-walled parenchyma cells (Pl. 2, E). Central ground tissue consisting of compactly arranged parenchyma. Vb's 10-11 in number arranged regularly in the form of a perimedullary ring. Bundle sheaths double, complete; O.S. parenchymatous, I.S. sclerenchymatous. Metaphloem, see sheath. Sclerenchyma strands (Ht. & W. 28 μ), inversely securiform, regularly alternating with groups of 1-3 epidermal cells. Tannin idioblasts abundant in the hypodermis.

ROOT. *Transverse section:* Outline subcircular as in *E. acutangula* (Pl. 2, A). Diameter of the specimen examined 0.47 mm. Epidermis: cells thick-walled, single-layered. Outer cortex lacunose, large, including concentrically and radially arranged air-cavities, those in contiguous radii separated by rows of parenchyma cells. Inner cortex consisting of 5-6 layers of compactly arranged sclerenchyma. Endodermis: cells wedge-shaped, uniformly thickened with triangular to elliptical lumina. Pericycle prominent, 1-layered. Large metaxylem element central, solitary. Vessel members (D. 40 μ in diameter). Protoxylem units 6. Metaphloem, see *E. atropurpurea.* Central ground tissue parenchymatous.

MATERIAL EXAMINED: Podanur, Coimbatore Dt., *Duraiswamy 6893;* Ooty, *Fyson 2289;* Chembrampakkam, N. Arcot Dt., *Govindarajalu 5299;* Irumbuliyur, Madras, *Go. 5355;* Red Hills, Madras, *Go. 5554, 5562, 5563;* Adayar, Madras, *Go. 5695;* Thiruvottiyur, Madras, *Go. 5743;* Aruppukottai, Ramnad Dt., *Go. 5839;* Poondi, Madras, *Go. 6363;* Coimbatore, *Rajasekaran, 14;* Thiruvannamalai, N. Arcot Dt., *Subramaniam 6958;* Pollachi, Coimbatore Dt., *Vasanthakumar 7334.*

Eleocharis retroflexa (Poir.) Urb. (*E. chaetaria* R. & S.)

SHEATH. *Abaxial surface:* Epidermal cells narrow and very much elongated axially; lateral walls smooth and thin; end walls straight. Stomata (L. 40 μ; W. 16 μ), long, narrow; subsidiary and interstomatal cells as in *E. atropurpurea.* Silica-cells long, very narrow, occurring in continuous files, each cell containing 6-8 larger cone-shaped silica-bodies intermixed with silica particles.

Transverse section: Epidermal cells very small, thin-walled, contrasting abruptly with 4-6-layered parenchymatous ground tissue. Sclerenchyma strands (Ht. & W. 12 μ), many, triangular, regularly alternating with each hypodermal cell (Pl. 1, C). Vb's 4 in number belonging to type I. Bundle sheaths single, parenchymatous, complete. Metaphloem of "intermediate type". Tannin idioblasts not common.

CULM. *Epidermis, surface view.* See sheath.

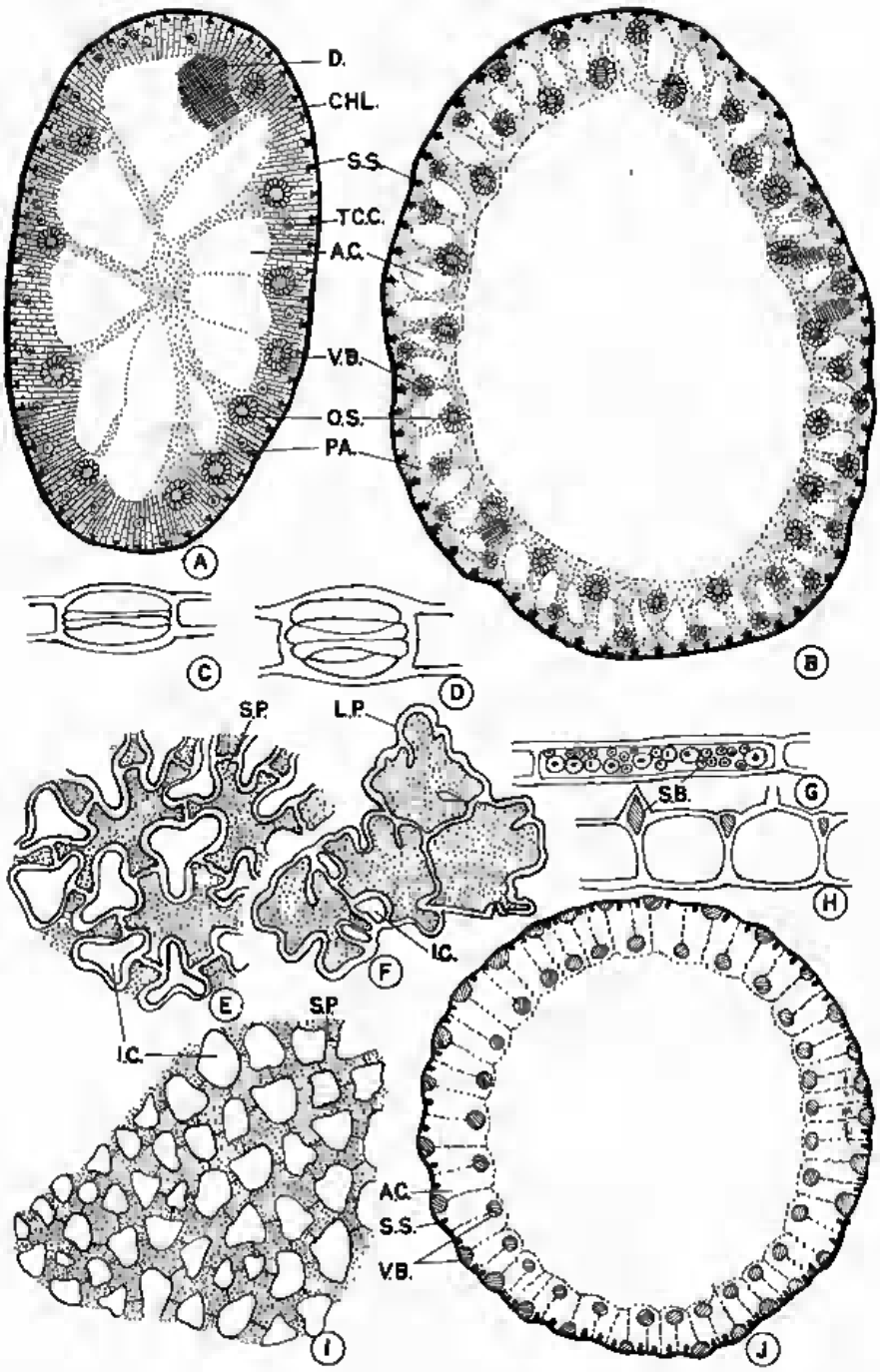
Transverse section: Outline pentagonal as in Pl. 1, A. Diameter of the culm examined 0.14 mm. Cuticle thin. Epidermal cells very small, contrasting abruptly with the following 1-2 layers of chlorenchyma next to epidermis (Pl. 1, A). Centre of culm lacunose, consisting of 5 large air-cavities with a small zone of sclerenchyma at the very centre (Pl. 1, A). Peripheral sclerenchyma strands (Ht. 8-12 μ; W. 16 μ), many, regularly alternating with a group of 3-4 epidermal cells, resembling those of the sheath. Vb's 5 in number each occupying a corner. Metaphloem, see sheath. Tannin idioblasts not seen.

ROOT. *Transverse section:* Diameter of the root examined 0.4 mm. Hypodermis consisting of a single layer of thick-walled parenchyma. Large metaxylem element central, solitary. Protoxylem units 12. Vessel members (D. 24 μ in diameter). Other details as in *E. atropurpurea* (Pl. 2, D).

MATERIAL EXAMINED: Moyar Valley, Ooty, *Govindarajalu & Swamy 1670;* Nalur, Mysore state, *Go. 5203, 5204;* Cheriakanum, Kerala state, *Go. 6452;* Kalikesam, Kanyakumari Dt., *Go. 7766;* Kambakkam, Andhra Pradesh, *Go. 8013;* Pallathadka, Mysore state, *&eshava Bhat 3;* Mariathoorkurichi, Kanyakumari Dt., *Mahi Mahizh 6988; sine loco, Rabecca Mary 5.*

Eleocharis spiralis (Rottb.) Roem. & Schult.

SHEATH. *Abaxial surface:* Epidermal cells axially elongated, narrow, thin-walled; lateral walls conspicuously sinuous, end walls straight. Sto-



Pl. 4. — **E. tetraquetra** : A, T. S. culm, ground plan (× 50). — **E. spiralis** : B, T. S. culm, ground plan (× 16). — **E. retroflexa** : C, Culm stoma, surface view (× 450); G, Culm silica-cell, surface view (× 450). — **E. congesta** : D, Culm stoma, surface view (× 450); H, T. S. sheath epidermis (*pro parte*, × 450). — **E. acutangula** : E, Diaphragm cells, surface view (× 450). — **E. atropurpurea** : F, Diaphragm cells, surface view (× 450). — **E. dulcis** : I, Diaphragm cells, surface view (× 115); J, T. S. culm, ground plan (× 20).

mata (L. 40 μ; W. 24 μ), elliptical; subsidiary cells low dome-shaped; interstomatal cells long with concave ends. Silica-cells short, with sinuous lateral walls, usually occurring in a single continuous row; each cell containing only small scattered silica-bodies.

Transverse section: Epidermis for the most part consisting of small, thin-walled cells but interrupted by sclerenchyma strands. Ground tissue compact, consisting of 6-8 layers of enlarged parenchyma (Pl. 2, C) contrasting abruptly with the smaller epidermal cells. Sclerenchyma strands (Ht. & W. 28-32 μ) pentagonal (Pl. 2, C) or triangular, each one regularly alternating with a group of 3-4 epidermal cells. Vb's 26-28 in number, belonging to type III A. Bundle sheaths double, O.S. parenchymatous, complete; I.S. sclerenchymatous, incomplete. Circumvascular sclerenchyma 3-4-layered, crescentiform, forming inner caps to all the bundles. Vessel members (D. 16 μ in diameter). Metaphloem of " intermediate type ". Tannin idioblasts common.

CULM. *Epidermis, surface view:* Epidermal cells, see sheath. Stomata (L. 48 μ; W. 28 μ), narrowly elliptical; subsidiary cells parallel-sided; interstomatal cells, see sheath. Silica-cells overlying the peripheral sclerenchyma strands occurring in 1-2 continuous files, each cell containing 6 (-7-9) large cone-shaped silica-bodies usually intermixed with several smaller bodies; silica-bodies sometimes all of the smaller type.

Transverse section: Outline subtriangular as in Pl. 4, B. Diameter of the culm examined 5.7 mm. Epidermal cells as in *E. dulcis*. Hypodermis consisting of 3-4 layers of enlarged parenchyma. Air-cavities arranged in a peripheral ring, each one separated from the next along its radial face by 1-2 rows of parenchyma cells. Air-cavities regularly alternating with vb's and traversed by diaphragms of parenchyma cells as in *E. acutangula* (Pl. 4, E). Sclerenchyma strands (Ht. & W. 20 μ), pentagonal, numerous, regularly alternating with a group of 2-3 epidermal cells. Vb's 46 in number arranged in two rings; bundles in the outer ring belonging to type III A, smaller than and regularly alternating with the bundles of the inner ring. Bundle sheaths and 4-5-layered circumvascular sclerenchyma as in sheath. Vessel members (D. 36-48 μ in diameter). Metaphloem of " regular type ". Centre of culm hollow. Starch grains present in hypodermal cells. Tannin idioblasts not observed.

STOLON. *Transverse section:* Outline subtriangular to somewhat irregular as in Pl. 2, H; diameter of the specimen examined 3.7 mm. Epidermal cells thick-walled. Hypodermis partly consisting of 2-3 layers of sclerenchyma and partly of 3-4 layers of compactly arranged parenchyma. Air-cavities 17, peripheral, regularly alternating with vb's. Peripheral air-cavities traversed by diaphragms of cells as in *E. acutangula* (Pl. 4, E). Central ground tissue also lacunose with air-cavities of variable size and irregular distribution (Pl. 2, H). Vb's 13-15 in number belonging to type III A and arranged in a single regular ring. Vessel members (D. 52-56 μ

in diameter). Metaphloem and bundle sheath, see culm. Circumvascular sclerenchyma 2-3-layered, crescentiform, forming an inner cap. Tannin idioblasts abundant in the hypodermis. Starch grains not seen.

ROOT. *Transverse section:* Diameter of the root examined 1.4 mm. Larger metaxylem elements 6-7 in number with as many protoxylem units. Vessel members (D. 48-56 μ in diameter). Other details as in *E. acutangula* (Pl. 2, A).

MATERIAL EXAMINED: Red Hills, Madras, *Govindarajalu 5541; 7950, 7976;* Sriperumpudur, Chinglepet Dt., *Go. 5674, 5675;* Thiruneermalai, Madras, *Go. 6407;* Mayuram, Thanjavur Dt., *Go. 6414;* Pollachi, Coimbatore Dt., *Vasanthakumar 7221.*

Eleocharis tetraquetra Nees

SHEATH. *Abaxial surface:* Epidermal cells moderately thin-walled, axially elongated and narrow; lateral walls smooth, end walls straight. Stomata not observed. Silica-cells axially elongated, narrow, thin-walled, smooth, occurring in single continuous files, each cell containing 8-12 large cone-shaped silica-bodies and several smaller scattered bodies.

Transverse section: Number of vb's 4. Tannin idioblasts few. Other details as in *E. spiralis.*

CULM. *Epidermis, surface view:* Epidermal cells, see sheath. Stomata (L. 52 μ; W. 24 μ), abundant; subsidiary and interstomatal cells as in *E. retroflexa* (Pl. 4, C). Silica-cells short, narrow, thin-walled, smooth, occurring in single continuous rows, each cell containing 2-4 (-5) large cone-shaped silica-bodies and several bodies smaller and scattered.

Transverse section: Outline oval as in Pl. 3, A. Diameter of the culm examined 1.6 mm. Epidermal cells, see sheath. Palisade chlorenchyma consisting of 3-5 layers present internally next to epidermis. Sclerenchyma strands (Ht. 20 μ; W. 16 μ), see *E. geniculata.* Vb's 11 in number forming a peripheral ring. Bundle sheaths double, parenchymatous, complete. Vessel members (D. 16-24 μ in diameter). Metaphloem of "regular type". Central ground tissue lacunose, including several air-cavities of variable size and each one of them delimited by 1-2 rows of parenchyma cells. Air-cavities traversed by diaphragms of cells resembling those of *E. acutangula* (Pl. 4, E). Tannin idioblasts common in the hypodermis. Starch grains abundant.

ROOT. *Transverse section:* Diameter of the root examined 0.75 mm. Exodermis 2-3 layered. For other details, see *E. congesta* (Pl. I, F).

MATERIAL EXAMINED: Sim's park, Coonoor, *Baskaran 7174;* Naduvattam, Ooty, *Govindarajalu 6129, 6143;* Aravankadu, Ooty, *Go. 6318;* Kodaikanal, Madurai Dt., *Go. 8373, 8374, 8381;* Kodaikanal, Madurai Dt., *Sundaram et al., 6808, 6825, 6832;* Yercaud, Salem Dt., *Vasanth Singh 7038.*

RHYNCHOSPORA

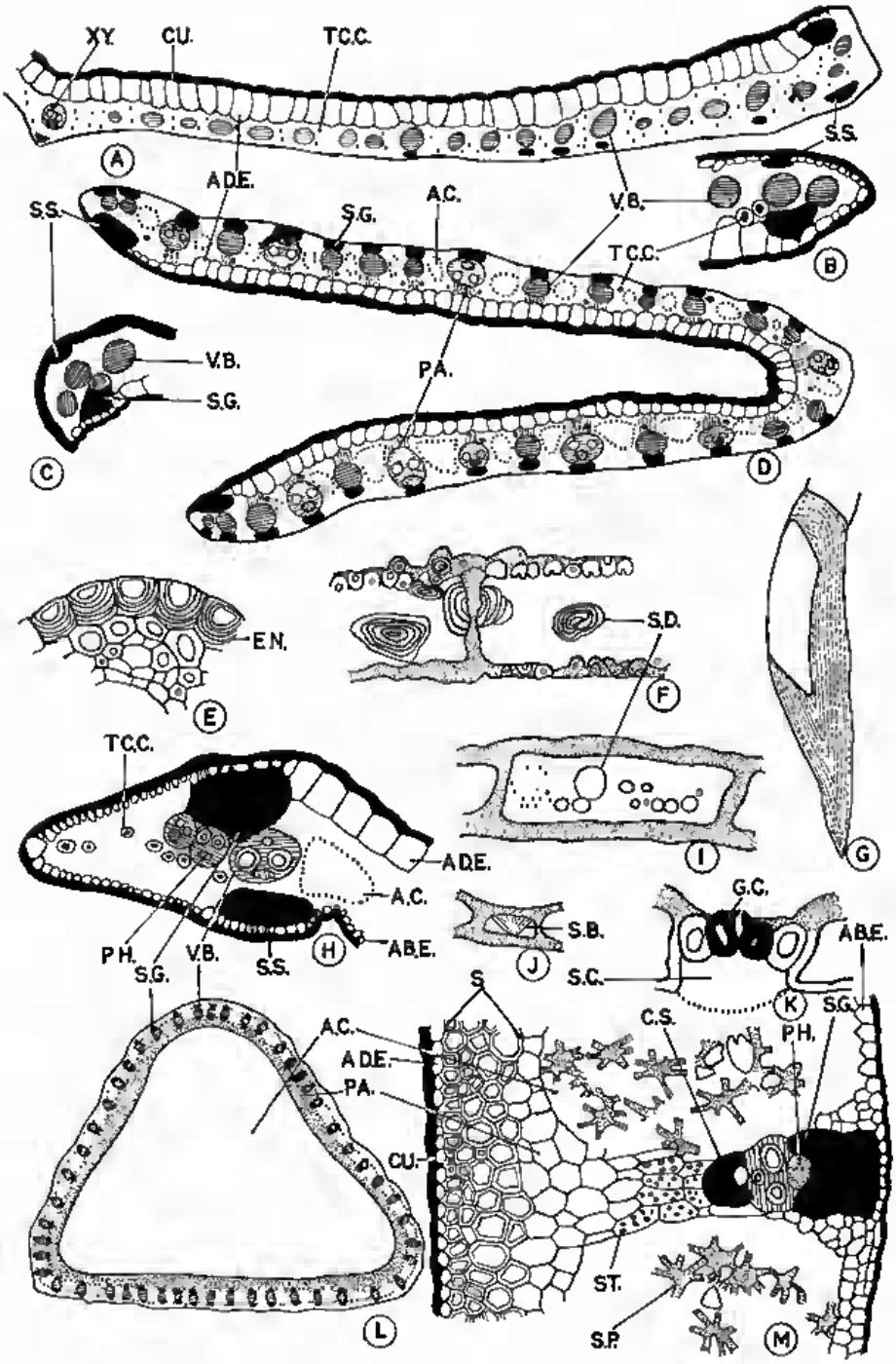
Rhynchospora corymbosa (L.) Britton (*R. aurea* Vahl)

LEAF. — *Abaxial surface:* Intercostal cells axially elongated, thick-walled, coarsely sinuous. Stomata (L. 32 μ; W. 28 μ), elliptical to oval; subsidiary cells low dome-shaped, often containing silica particles. Stomata sometimes partially or completely surrounded by silica deposits in various patterns (GOVINDARAJALU, 1969). Interstomatal cells usually long and narrow. Costal cells long or short, thin-walled, each containing 1-2 cone-shaped silica-bodies without satellites. Interstomatal cells short, cubical, each containing a single silica-body. Angular prickles (L. 225 μ), exceedingly thick-walled (Pl. 5, G) and sometimes even without lumen, occurring in continuous ascending rows at the leaf margin.

Adaxial surface: Epidermal cells rectangular to hexagonal. Intercostal cells long and narrow. End walls sometimes overlaid with convex or biconvex silica deposits (GOVINDARAJALU, 1969). Cone-shaped silica-bodies without satellites and irregularly distributed also present in certain cells. Cells overlying the submarginal sclerenchyma strands containing silica-bodies (see costal cells).

Lamina, transverse section: Outline shallowly and widely V-shaped (Pl. 7, D, F) with median obliquely triangular keel. Margin subacute (Pl. 7, F). Certain abaxial epidermal cells sometimes each containing a cone-shaped silica-body based on the outer tangential wall (Pl. 5, J; 7, A). Bulliform cells 6-7, arranged in regular fan-shaped groups; those over the lateral veins in a group of three. Hypodermis of 1-2 layers of translucent cells subjacent to median groups of bulliform cells (Pl. 7, D) and sometimes also present beneath lateral bulliform cells. Guard cells of stomata with conspicuous outer ledges (Pl. 5, K). Mesophyll homogeneous composed of 2-3 layers of chlorenchyma surrounding the air-cavities and vb's. Vb's 49 in whole T.S. lamina, Metaphloem, see (7) above. Bundle sheaths, see (6) above; I.S. complete, O.S. incomplete. Abaxial keel and marginal sclerenchyma strands (Ht. 45-60 μ; W. 60-135 μ), pulviniform to rectangular; abaxial sclerenchyma girders (Ht. 15-90 μ; W. 60-150 μ), crescentiform (Pl. 7, D). Air-cavities large, conspicuous, traversed by plates of stellate parenchyma as in sheath (Pl. 5, M; 6, I). Tannin idioblasts rather abundant.

SHEATH. *Abaxial surface:* Cells axially elongated or short; walls exceedingly thick, straight or curved or end walls overlapping and provided with pseudopits (SOLEREDER, 1908, p. 896). Elongated cells containing 1-3 silica-bodies or few to many lamellated silica deposits per cell, the bodies being free in the lumen or attached to the end and lateral walls (Pl. 5, F). Each short cell containing an oval, cubical or polygonal silica-body. Silica-cells overlying sclerenchyma strands narrow, axially elongated, thin-walled, sinuous, each containing 3-4 (-6) cone-shaped silica-bodies surrounded by satellites. Stomata (L. 44 μ; W. 36 μ) more or less circular or oval, uni-



Pl. 5. — **Rhynchospora wightiana** : A, T. S. lamina, ground plan (× 75); B, C, T. S. laminal margins (× 75); E, T. S. part of endodermis (× 450). — **R. rubra** : D, T. S. sheath (× 60). — **R. corymbosa** : F, Surface view of epidermal cells of sheath (× 450); G, Marginal angular prickle (× 190); H, T. S. laminal margin (× 90); I, Surface view of culm epidermal cell (× 450); J, T. S. abaxial epidermal cell (× 450); K, T. S. stoma (× 540); L, T. S. sheath, ground plan (diagrammatic); M, T. S. part of sheath (× 75).

formly thickened; subsidiary cells parallel-sided or low dome-shaped. Interstomatal cells as in lamina.

Transverse section: Obtusely triangular as in Pl. 5, L. Epidermal cells uniform. Ground tissue multilayered. Epidermal cells containing silica-bodies as in the culm. Adaxial hypodermis consisting of 4-6 layers of sclerenchyma followed by parenchyma (Pl. 5, M). Circumvascular sclerenchyma crescentiform forming an inner cap and consisting of 6-8 layers. Vb's many, large and small. Bundle sheaths, see leaf. Air-cavities many, regularly alternating with vb's, see leaf. Tannin idioblasts, see leaf. Starch grains abundant (Pl. 5, M).

CULM. *Epidermis, surface view:* Cells as in sheath. Long cells sometimes containing several silica-bodies per cell of different sizes (Pl. 5, I). Silica-cells over the peripheral sclerenchyma strands narrow, walls thick and sinuous, each cell containing silica-bodies similar to those in the long cells and occasionally silica particles as well. Stomata (L. 40-44 μ; W. 32 μ), see sheath; subsidiary cells, see leaf.

Transverse section: Outline obtusely triangular with convex sides as in Pl. 7, C. Cells overlying the peripheral sclerenchyma strands containing cone shaped silica-bodies based on the outer and radial walls. Air-cavities peripheral, almost regularly alternating with vb's of the peripheral ring (Pl. 7, C). Air-cavities traversed by diaphragms of stellate parenchyma. Hypodermis chlorenchymatous. Ground tissue consisting of compactly arranged parenchyma; central ground tissue tending to become lacunose, ultimately the pith becoming fistular. Sclerenchyma strands (Ht. 15-22 μ; W. 60 μ), 2-4-layered, pulviniform to rectangular. Interfascicular ring of sclerenchyma present consisting of 4-10 layers of cells. Circumvascular sclerenchyma sheaths 2-5-layered, present around all of the bundles. Vb's many; peripheral bundles forming an outer ring and the inner bundles scattered. Vessel members (D. 45-60 μ in diameter). Tannin idioblasts less common. Starch grains present in the neighbourhood of the vb's.

INFLORESCENCE AXIS. *Transverse section:* Shape as in Pl. 7, J. Cuticle thick and undulate. Epidermal cells over the peripheral sclerenchyma girders containing cone-shaped silica-bodies based on the outer and radial walls. Hypodermis consisting of palisade chlorenchyma. Air-cavities absent. Ground tissue, see culm. Centre of axis hollow. Sclerenchyma girders (Ht. 44-60 μ; W. 60-68 μ) deeply crescentiform; interfascicular band of sclerenchyma also present. 1-3-layered circumvascular sclerenchyma present around all smaller bundles. Vb's 18-19 in number, 6 larger and the rest smaller and variable in size, all bundles arranged in forming a single ring. Bundle sheaths double; O.S. parenchymatous, incomplete, I.S. sclerenchymatous, complete. Vessel members (D. 20-24 μ in diameter). Tannin idioblasts abundant.

ROOT. *Transverse section:* Diameter of the root examined 1.7 mm. Exodermal and subjacent layers of cells exceedingly thick-walled; some

exodermal cells each containing a cone-shaped silica-body sometimes accompanied by an aggregation of smaller silica particles. Cortex two zoned; outer zone narrow, consisting of 3-5 layers of parenchyma; inner lacunose containing several concentrically arranged air-cavities, as illustrated for *R. corymbosa* (Pl. 6, A). Endodermis prominent; cells isodiametric with U-shaped thickenings and large lumina. Pericycle distinct, parenchymatous. Metaxylem elements 7 in number with as many protoxylem units. Vessel members (D. 45-52 μ in diameter) with circular outline. Metaphloem distinct, each strand consisting of a group of 5-7 cells. Central ground tissue sclerenchymatous.

MATERIAL EXAMINED: Cheriakanum, Thekkadi, Kerala State, *Govindarajalu 6457;* Kilaviyar, Kanyakumari Dt., *Go. 7350;* Courtallam, Tirunelveli Dt., *Joseph Verghese 87;* Cheriakanum, Kerala state, *Martha Grisilda s.n.;* Anamalais, Coimbatore Dt., *Rabecca 7070;* Parambikulam, Kerala state, *Ramamurthi 7050;* Anand, N. Kanara, *Sedgwick 3255, 3280.*

Rhynchospora gracillima Thw.

LEAF. *Abaxial surface:* Intercostal cells either somewhat elongated or short; walls thick, corrugated. Short cells containing variously shaped silica-bodies. Stomata (L. 28 μ; W. 20 μ), almost circular; subsidiary cells as in *R. corymbosa.* Interstomatal cells elongated. Costal cells short, narrow, thick-walled, each cell containing 1-2 cone-shaped silica-bodies surrounded by satellites. Angular thick-walled, marginal prickles (L. 68 μ), with well marked barbs and fairly large lumina, present in ascending rows.

Adaxial surface: Cells cubical as in *R. rugosa.* Angular prickles as described for the abaxial surface, present at regular intervals in intercostal regions adjacent to veins.

Lamina, transverse section: Outline thickly crescentiform as in Pl. 6, C; keel broad, U-shaped; margins obtuse, upwardly directed. Whole of adaxial surface consisting of (10-) 11 bulliform cells except for a few much smaller marginal cells (Pl. 6, C). Hypodermis absent. Stomata and mesophyll as in *R. corymbosa.* Abaxial sclerenchyma girders (Ht. 22-38 μ; W. 82-92 μ) ascending crescentiform. Adaxial submarginal sclerenchyma strands (Ht. 22 μ; W. 46 μ), pulviniform to rectangular. Air-cavities regularly alternating with vb's and traversed by diaphragms composed of cells resembling those in *R. corymbosa.* Bundle sheaths as in *R. corymbosa.* Vb's 7 in number, large and small, regularly alternating with each other. Tannin idioblasts not seen.

SHEATH. — *Abaxial surface:* Cells short, narrow; walls thin, sinuous. Stomata (L. 32 μ; W. 28 μ), subcircular; subsidiary and interstomatal cells as described for leaf. Costal cells over the sclerenchyma strands short and narrow; walls thin, sinuous. Each cell containing 1-2 cone-shaped silica-bodies without satellites.

Transverse section : Keel U-shaped. Adaxial and abaxial epidermal cells uniform in size. Cuticle thicker on the abaxial than on the adaxial surface. Ground tissue few-layered, chlorenchymatous. Sclerenchyma girders (Ht. 8 μ; W. 40-48 μ), 2-layered, thinly crescentiform. Vb's 7 in number, large or small. Metaxylem vessel members (D. 12-16 μ in diameter). Air-cavities regularly alternating with vb's and traversed by diaphragms of lobed parenchymatous cells. Bundle sheaths, see lamina. Tannin idioblasts common.

CULM. *Epidermis, surface view :* Cells short, narrow, thick-walled as in *R. corymbosa.* Stomata (L. 20-24 μ; W. 16 μ), narrowly elliptical, walls of guard cells uniformly thickened; subsidiary and interstomatal cells as described for leaf. Cells overlying the peripheral sclerenchyma strands short, narrow, thin-walled, each cell containing 1-2 (-4) cone-shaped silica-bodies surrounded by satellites.

Transverse section: Outline irregular as in Pl. 6, F. Stomata as in *R. corymbosa.* Hypodermis as in *R. rugosa.* Air-cavities absent. Central ground tissue consisting of enlarged parenchyma cells. Sclerenchyma girders (Ht. 24-28 μ; W. 80 μ), crescentiform; an uninterrupted inter fascicular band of sclerenchyma also present. Circumvascular scleren chyma forming inner caps to all larger bundles, sometimes extending laterally and uniting with adjacent caps. Vb's 9 in number, larger and smaller mostly alternating with each other and the bundles collectively forming a regular ring (Pl. 6, F). Metaxylem vessel members (D. 16-20 μ in diameter). Bundle sheaths single, sclerenchymatous, complete. Tannin idioblasts not seen.

ROOT. *Transverse section:* Diameter of the root examined 0.4 mm. Exodermis and subjacent layers of cells as in *R. rugosa.* Cortex resembling that of *R. corymbosa.* Innermost part of cortex sclerenchymatous. Endo-dermis as in *R. rugosa.* Pericycle as in *R. corymbosa.* Metaxylem vessel central, solitary (D. 45 μ in diameter). Protoxylem units 6 in number. Metaphloem and central ground tissue as in *R. corymbosa.*

MATERIAL EXAMINED: Arakku Valley, Vizag Dt., *Balakrishnan 10773* (MH).

Rhynchospora rubra (Lour.) Makino (*R. wallichiana* (Nees) Kunth)

LEAF. *Abaxial surface :* Intercostal cells mostly short, walls exceedingly thick, almost smooth but intermixed with long cells. Short cells each containing a single silica-body per cell. Costal cells long and narrow, walls smooth and thick, each cell containing 2-3 silica-bodies without satellites. Silica deposits of unusual shapes and variable sizes quite common in cells of all kinds including the guard cells of the stomata as already reported for *R. corymbosa* (GOVINDARAJALU, 1969). Thick-walled rigid prickles (L. 140-200 μ), angular with well marked barbs occurring

over the costae. Stomata (L. 36-44 μ; W. 32 μ) almost circular; subsidiary and interstomatal cells as in *R. corymbosa*. Stomata of normal type very rare (GOVINDARAJALU, 1969).

Adaxial surface: Cells variable in size and shape (hexagonal, cubical, rounded); walls exceedingly thick and smooth. Each cell containing 1-2 warty (Pl. 8, B, C) or more rarely smooth silica-bodies per cell attached to the lateral walls or at the junction of cells. Submarginal silica-cells occurring in a single uninterrupted row, each containing 1 cone-shaped silica-body without satellites.

Lamina, transverse section: Outline asymmetrical, V-shaped, with slight median adaxial groove as in Fig. 8, D; keel triangular; leaf margin subacute. Epidermal cells with thick outer walls. Mesophyll mostly composed of radiating chlorenchyma surrounding the vb's. Air-cavities absent. Bulliform cells: median adaxial epidermal cells not larger than their neighbours. Submarginal and keel sclerenchyma strands (Ht. 44-48 μ; W. 80-84 μ) pulviniform; abaxial girders (Ht. 12-40 μ; W. 24-60 μ) pulviniform. Bundle sheaths both complete excepting in the keel bundle in which O.S. incomplete. Vb's 29, large and small, those of different sizes not regularly alternating with each other. Tannin idioblasts abundant in the outer parenchymatous sheath.

SHEATH. *Abaxial surface:* Cells long or short. Costal cells over the peripheral sclerenchyma strands long, narrow, thin-walled, sinuous, each cell containing (2-) 4 small cone-shaped silica-bodies surrounded by satellites. Submarginal cells occurring in 4-6 continuous rows, thick-walled, each containing 1-2 cone-shaped silica-bodies surrounded by satellites. Stomata (L. 44 μ; W. 32 μ) broadly elliptical; subsidiary cells triangular. Interstomatal cells long or short; walls of guard cells and subsidiary cells sometimes thickened. Angular prickles resembling those of *R. corymbosa* containing some granular contents.

Transverse section: U-shaped as in Pl. 5, D. Keel inconspicuous. Margin subacute. Adaxial epidermal cells, except at the sheath margins larger than those of the abaxial epidermis. Bulliform cells scarcely distinguishable. Adaxial hypodermis extending the full width of the lamina, consisting of 1-2 layers of translucent cells. Stomata as in *R. corymbosa*. Air-cavities regularly alternating with vb's (Pl. 5, D). Air-cavities traversed by diaphragms of cells similar to those of *R. corymbosa*. Vb's 29-30 in number of 2 different sizes. Metaxylem vessel elements (D. 28 μ in diameter). Bundle sheaths double; O.S. complete around smaller and incomplete around larger bundles. Abaxial sclerenchyma girders (Ht. 19 μ; W. 38 μ) and adaxial submarginal strands (Ht. 16-20 μ; W. 40-44 μ) pulviniform. Tannin idioblasts common in the vicinity of vb's.

CULM. *Epidermis, surface view:* Cells long and narrow; walls moderately thick, smooth. Stomata (L. 32-36 μ; W. 28 μ) somewhat rounded;

subsidiary and interstomatal cells as in *R. corymbosa*. Stomata sometimes containing irregularly shaped silica deposits. Silica-cells over the peripheral sclerenchyma strands long, narrow, thin-walled, each containing 3-5 cone-shaped silica-bodies without satellites.

Transverse section: Outline obtusely subtriangular and slightly sinuous as in Fig. 8, A. Epidermal cells thick-walled. Hypodermis consisting partly of 2-3 layers of chlorenchyma and partly of parenchyma. Centre of culm hollow. Sclerenchyma girders (Ht. 48-80 μ; W. 80-120 μ) descendingly crescentiform; sclerenchyma strands (Ht. 20-40 μ; W. 32-48 μ) pulviniform or angular, often pentangular. Interfascicular band of sclerenchyma absent. Air-cavities absent. Vb's of 2 distinct sizes arranged in a regular peripheral ring, the larger containing protoxylem lacunae. Metaxylem vessel members (D. 32 μ in diameter). Bundle sheaths, both incomplete. Tannin idioblasts common.

ROOT. *Transverse section:* Diameter of the root examined 0.6 mm. Exodermis as in *R. gracillima* and cortex as in *R. corymbosa*. Pericycle distinct, sclerenchymatous, discontinuous. Endodermis and central ground tissue resembling those of *R. gracillima*. Metaxylem units 6 in number, peripheral, accompanied by as many protoxylem units. Large metaxylem vessel members (D. 36-40 μ in diameter). Metaphloem as in *R. corymbosa*.

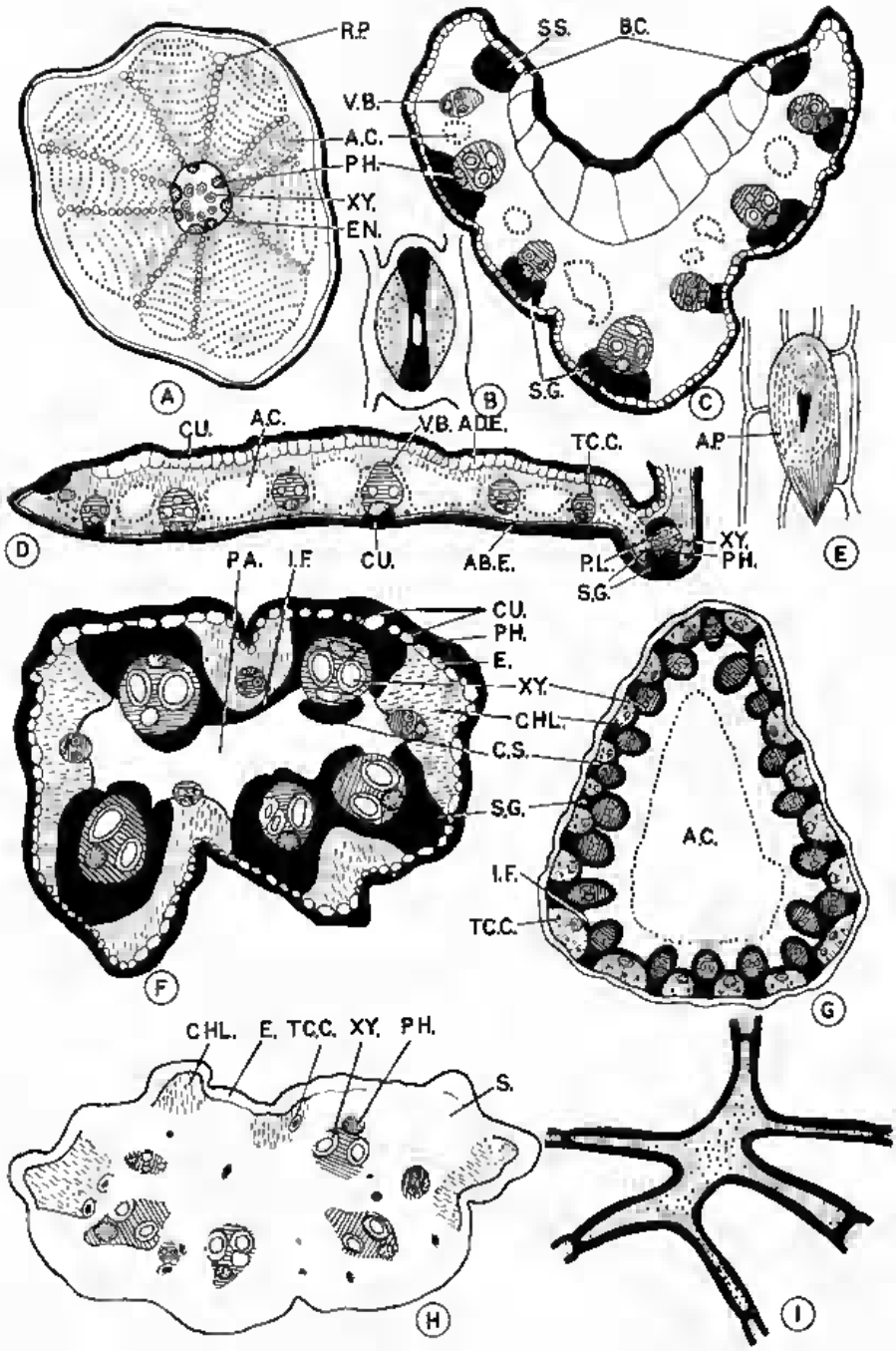
MATERIAL EXAMINED: Ambalapuzha, Kerala state, *Lady Bourne MH 53794, 73953* (MH).

Rhynchospora rugosa (Vahl) Gale (*R. glauca* Vahl)

LEAF. *Abaxial surface:* Intercostal cells long or short; lateral walls moderately sinuous, exceedingly thick, with pseudo-pitting (SOLEREDER, 1908, p. 896), end walls overlapping or straight. Intercostal cells both long and short similar to those in the sheath of *R. corymbosa;* long cells containing silica-bodies as in Fig. 5, F. Stomata (L. 32-36 μ; W. 24 μ); subsidiary cells parallel-sided. Interstomatal cells long. Costal cells short and narrow; walls thin, sinuous. Each cell containing (1-) 2 (-4) cone-shaped silica-bodies with satellites.

Adaxial surface: Cells variable in size and shape, some hexagonal, walls exceedingly thick, smooth, sometimes with pseudo-pitting. Warty silica-bodies of various shapes present as in *R. rubra* (Pl. 8, B). Submarginal costal cells narrow, elongated; walls thick, somewhat sinuous, each cells containing (1-) 2-3 large cone-shaped silica-bodies without satellites.

Lamina, transverse section: Outline V-shaped as in Pl. 6, D; keel rounded, somewhat oblique. Margins acute. Adaxial epidermal cells devoid of siliceous contents. Abaxial epidermal cells overlying the sclerenchyma strands as well as the adaxial cells over the submarginal sclerenchyma



Pl. 6. — **R. corymbosa** : A, T. S. root, ground plan (× 30); I, T. S. stellate parenchyma (× 450). — **R. rubra** : B, Surface view of stoma from leaf (× 450). — **R. gracillima** : C, T. S. lamina, ground plan (× 115); F, T. S. culm, ground plan (× 190). — **R. rugosa** : D, T. S. part of lamina, ground plan (× 60); E, Surface view of angular prickle from culm (× 450); G, T. S. culm, ground plan (× 35); H, T. S. inflorescence axis, ground plan (× 190).

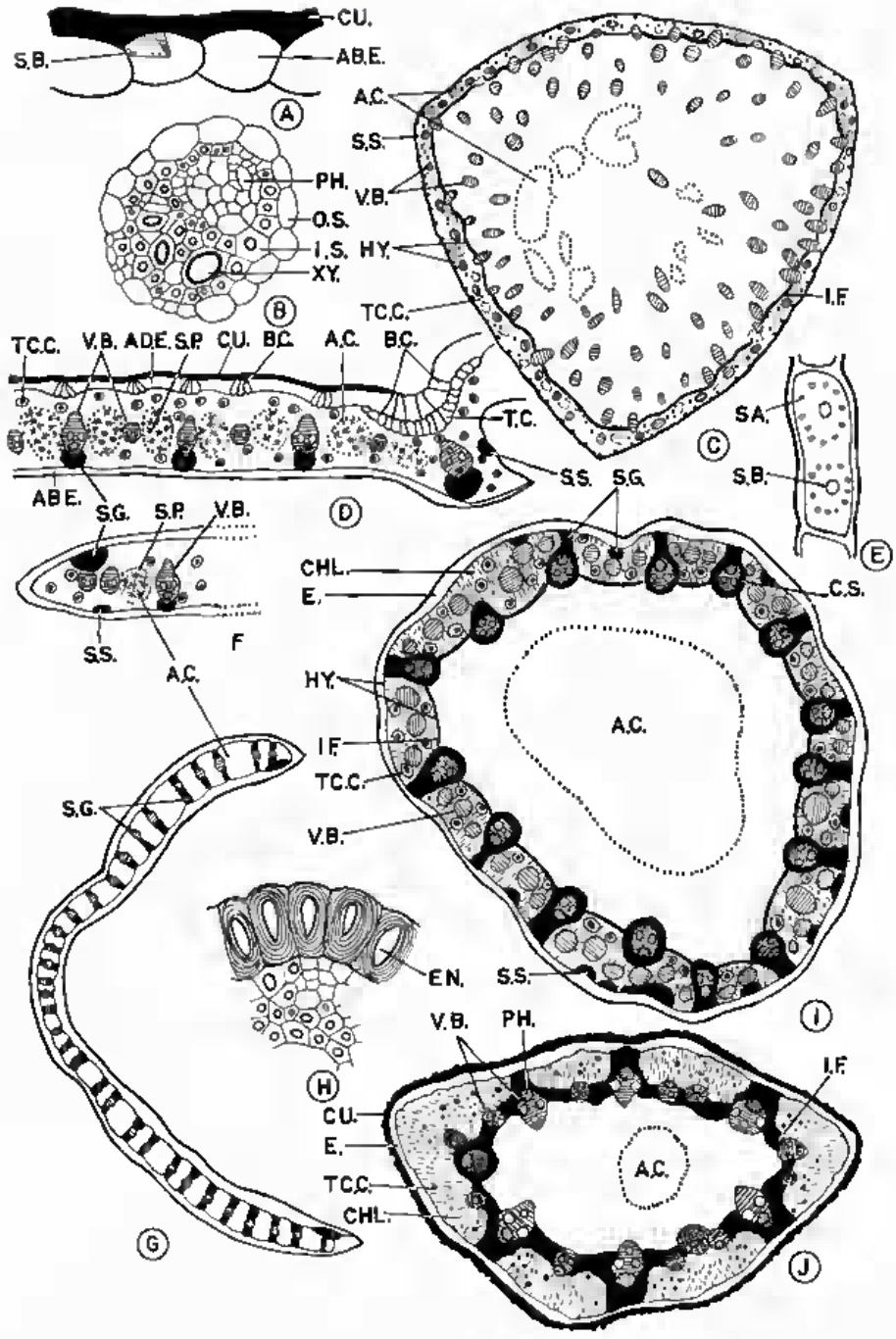
strands containing warty silica-bodies. Median adaxial epidermal cells not bulliform. Bundle sheaths, double, O.S. incomplete, I.S. complete. Translucent hypodermal cells absent. Stomata and mesophyll as in *R. corymbosa*. Vb's 15, of 2 different sizes, the larger and smaller bundles alternating with each other. Abaxial sclerenchyma girders (Ht. 12 μ; W. 80 μ), adaxial submarginal girders (Ht. 48 μ; W. 88 μ) pulviniform; both abaxial and adaxial crescentiform girders present in the keel (Ht. 40-48 μ; W. 80-88 μ). Air-cavities large regularly alternating with vb's and traversed by diaphragms consisting of lobed parenchyma. Tannin idioblasts, see *R. corymbosa*.

SHEATH. *Abaxial surface:* Cells as in intercostal cells of leaf. Silica-cells overlying the sclerenchyma strands short or more rarely elongated. walls thin, markedly sinuous, each cell containing 1-2 (-4) cone-shaped silica-bodies surrounded by satellites. Stomata (L. 40 μ; W. 24 μ); subsidiary cells low dome-shaped. Interstomatal cells long.

Transverse section: Adaxial and abaxial epidermal cells as in *R. rubra;* cells overlaid with silica deposits. Cuticle thick. Sheath margins abruptly acute. Hypodermis: adaxial consisting of 1 continuous layer of cells; abaxial similar but discontinuous. Abaxial sclerenchyma girders (Ht. 16 μ; W. 48 μ), deeply crescentiform; adaxial submarginal girders (Ht. 12 μ; W. 48 μ) rectangular. Bulliform cells conspicuous, in median groups of 4-5. Air-cavities conspicuous, large, traversed by diaphragms of lobed parenchyma. Chlorenchyma 1-layered present around the air-cavities. Vb's 15 in number, of 2 distinct sizes and situated on the partitions between the air-cavities. Metaxylem vessel members (D. 28-40 μ in diameter). Starch grains present in the partition layer of cells. Tannin idioblasts not common.

CULM. *Epidermis, surface view:* Cells long or short; walls thin, sinuous. Stomata (L. 28-32 μ; W. 20 μ); subsidiary cells low dome-shaped. Interstomatal cells long. Silica-cells overlying the peripheral sclerenchyma strands of restricted occurrence, see sheath. Angular, pointed prickles (L. 48 μ), occurring between rows of cells overlying the peripheral sclerenchyma strands (Pl. 6, E).

Transverse section: Outline obtusely triangular with slightly ribbed sides (Pl. 6, G). Epidermal cells containing silica-bodies. Guard cells and substomatal chambers as in *R. corymbosa*. Hypodermis interrupted, consisting of several layers of chlorenchyma. Ground tissue parenchymatous. Centre of culm hollow. Sclerenchyma girders (Ht. 60-105 μ; W. 45-75 μ), descendingly crescentiform; interfascicular band of sclerenchyma and circumvascular sclerenchyma as shown in Pl. 6, G. Air-cavities usually absent, when present traversed by diaphragms of lobed parenchyma. Vb's 45 in number, comprising large and small bundles forming a regular peripheral ring; smaller bundles alternating regularly



Pl. 7. — **R. corymbosa** : A, T. S. part of abaxial epidermis of leaf (× 450); B, T. S. laminal bundle (× 450); C, T. S. culm, ground plan (× 12); D, T. S. part of lamina, ground plan (× 30); F, T. S. laminal margin (× 30); J, T. S. inflorescence axis, ground plan (× 35). — **R. rugosa** : E, Surface view of silica-cell (× 540). — **R. wightiana** : G, T. S. sheath, ground plan (× 39); I, T. S. culm, ground plan (× 60). — **R. gracillima** : H, T. S. part of endodermis (× 450).

with larger bundles. Metaxylem vessel members (D. 30-60 μ in diameter). Tannin idioblasts abundant.

INFLORESCENCE AXIS. *Transverse section:* Outline irregular as in Pl. 6, H. Cuticle thick. Epidermal cells over the peripheral sclerenchyma strands, containing silica-bodies. Guard cells and substomatal chambers as in *R. corymbosa*. Ridges containing several layers of chlorenchyma (Pl. 6, H). Air-cavities absent. Ground tissue sclerenchymatous. Sclerenchyma girders (Ht. 12 μ; W. 32 μ) (not very distinct because united with sclerenchymatous ground tissue) pulviniform to rectangular. Vb's 9 in number, comprising alternating large and small bundles arranged in a peripheral ring. Metaxylem vessel members (D. 16 μ in diameter). Tannin idioblasts common.

ROOT. *Transverse section:* Diameter of the root examined 1.2 mm. Exodermis consisting of suberized cells variable in size and shape, each cell containing 1-4 silica-bodies based on the lateral walls without satellites. Cortex two-zoned; outer 2-4-layered, narrow; inner zone, as in *R. corymbosa;* cells of radiating rows of parenchyma filled with starch grains. Endodermis prominent; cells wedge-shaped, uniformly thickened; lumen broad containing starch grains. Pericycle not clearly distinguishable. Metaxylem vessel elements 8 in number with as many protoxylem units. Vessel members (D. 28-36 μ in diameter). Metaphloem and central tissue as in *R. corymbosa*.

MATERIAL EXAMINED: Peermedu, Kerala state, *Baskaran, 38, 39, 42;* Berberis shola, Kodaikanal, Madurai Dt., *Bourne 1459;* Pykara, Nilgiris Dt., *Fyson 2564, 2702, 2704;* Ooty, *Govindarajalu 6127;* Naduvattam, Nilgiris Dt., *Go. 6131;* Kalhathigiri, Mysore state, *Go. 8772;* Munnar, Madurai Dt., *Jagannathan 6*.

Rhynchospora wightiana (Nees) Steud.

LEAF. *Abaxial surface:* Intercostal cells long and short; walls thin, lateral walls somewhat sinuous, end walls straight. Short cells each containing an angular or smooth, oblong or squarrish silica-body. Costal cells long and narrow; walls thin, sinuous. Each cell containing 2-4 (-5) usually 4 cone-shaped silica-bodies without satellites. Stomata (L. 44 μ; W. 32 μ) broadly elliptical; subsidiary cells triangular. Interstomatal cells long or short. Angular prickles with some granular contents present, resembling those of *R. corymbosa*.

Adaxial surface: As in *R. rubra*.

Lamina, transverse section: Flat as in Pl. 5, A. Keel shortly triangular. One leaf margin obliquely truncate and the other acute. Adaxial and abaxial epidermis, as in *R. rubra*. Bulliform cells scarcely distinguishable either above the midrib or over the lateral veins. Stomata, as in *R. rugosa*, Mesophyll homogeneous, consisting of spongy tissue. Abaxial scleren-

chyma strands (Ht. 13 μ; W. 19-38 μ), 1-2 (-3)-layered, pulviniform; adaxial and abaxial submarginal strands (Ht. 34-40 μ; W. 44-52 μ) pulviniform. Air-cavities rare; when present traversed by diaphragms of lobed parenchyma. Vb's 43 in number, large and small, not showing regular alternation. Metaxylem vessel members (D. 28-32 μ in diameter). Bundle sheaths double, both complete and having some undetermined contents. Tannin idioblasts very common.

SHEATH. *Abaxial surface:* Cells moderately long, thick-walled, narrow, sinuous. Prickles (L. 150-300 μ), straight or curved, thick-walled, barbed with narrow lumina and lamellated end walls. Stomata (L. & W. 28 μ) rounded; subsidiary and interstomatal cells as in leaf. Costal cells short, and narrow, walls moderately thin, sinuous, each cell containing 2-3 cone-shaped silica-bodies without satellites.

Transverse section: Outline thinly crescentiform as in Pl. 7, G. Adaxial and abaxial epidermal cells, as in *R. rubra*. Stomata as in leaf. Mesophyll as in *R. corymbosa*. Vb's 33-40 in number comprising large and small bundles without showing regular alternation. Bundle sheaths as in leaf. Abaxial and adaxial sclerenchyma girders (Ht. 24-28 μ; W. 40-52 μ) baculiform. Air-cavities large, conspicuous, alternating regularly with vb's and containing lobed parenchyma cells. Tannin idioblasts as in lamina.

CULM. *Epidermis, surface view:* Cells axially elongated, walls exceedingly thick with pseudo-pitting, sinuous; end walls straight (overlapping). Cells over the peripheral sclerenchyma strands long and narrow; walls thin, smooth. Each cell containing 2-4 cone-shaped silica-bodies without satellites. Stomata (L. 36 μ; W. 28 μ), broadly elliptical to somewhat rounded; subsidiary and interstomatal cells, as in *R. corymbosa*. Stomata thickened with siliceous deposits at polar ends.

Transverse section: Outline obscurely triangular as in Pl. 7, I. Epidermal cells as in *R. corymbosa*. Hypodermis consisting of 1-2 discontinuous layers of chlorenchyma. Peripheral air-cavities absent. Stomata as in *R. corymbosa*. Ground tissue consisting of 3-6 layers of enlarged parenchyma contrasting abruptly with the cells of the hypodermis. Centre of culm hollow. Sclerenchyma strands (Ht. 12-24 μ; W. 20-32 μ) 2-4-layered pulviniform; sclerenchyma girders (Ht. 44-64 μ; W. 40-44 μ), see *R. rugosa*. Interfascicular band of sclerenchyma present (Pl. 7, I). Circumvascular sclerenchyma, surrounding all larger vb's. Vb's 60-65 in number (13 larger + 47-52 smaller) arranged in two peripheral rings. Metaxylem vessel members (D. 16-20 μ in diameter). Bundle sheaths, see *R. gracillima*. Tannin idioblasts abundant.

ROOT. *Transverse section:* Diameter of the root examined 0.5 mm. Exodermis and cortex as in *R. gracillima*. Endodermis prominent; cells walls exceedingly thick with lamellated U-shaped thickenings; lumina much reduced, excentric (Pl. 5, E). Pericycle discontinuous, sclerenchy-

matous. Metaxylem vessel solitary, central. Proxylem units 6. Large vessel members (D. 36 μ in diameter). Metaphloem, as in *R. rubra*. Central ground tissue scanty as in *R. corymbosa*.

MATERIAL EXAMINED: Jahlsuri, S. Kanara, *Barber 2441* (MH).

SCLERIA

Scleria caricina (R. Br.) Benth.

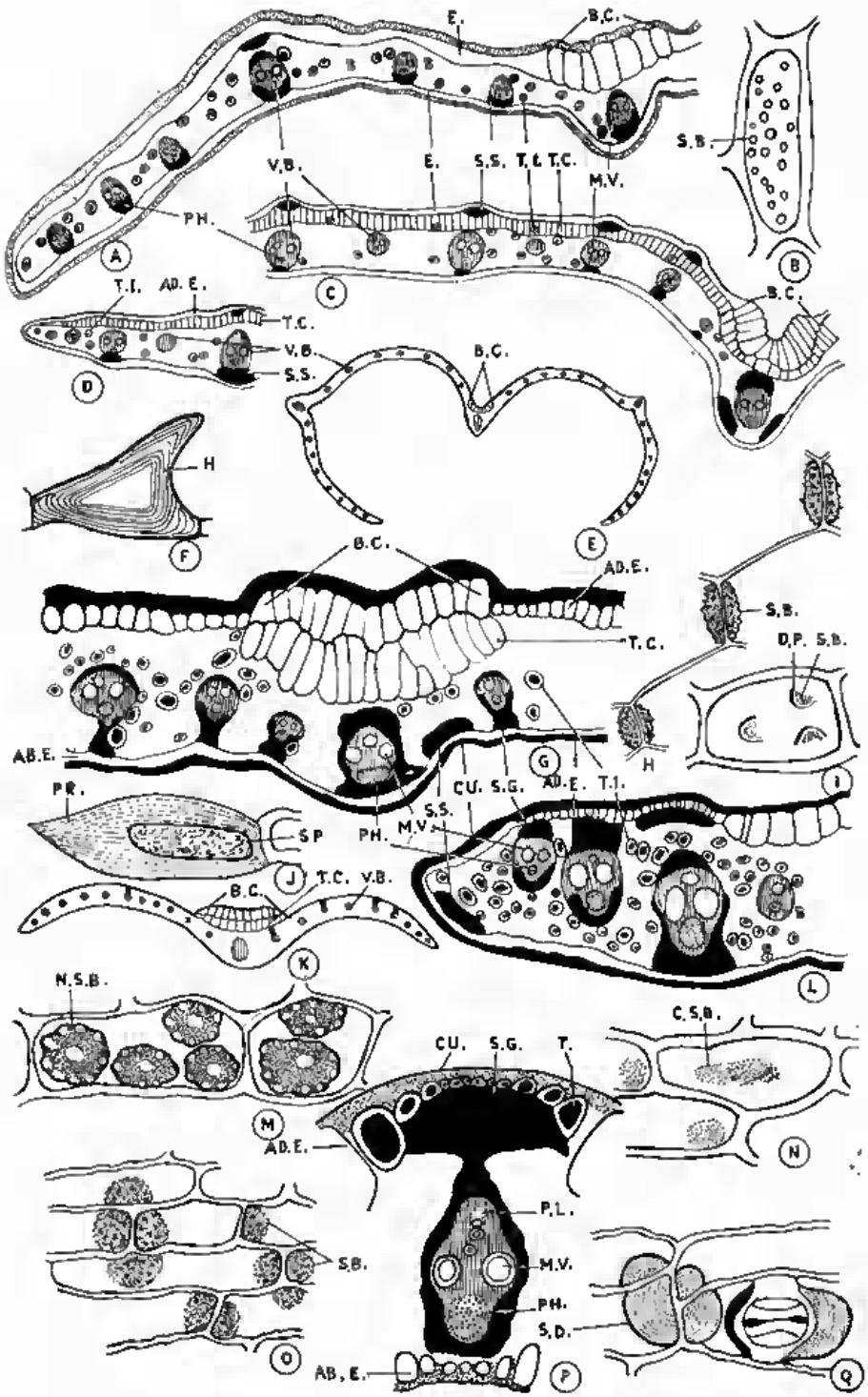
LEAF. *Abaxial surface:* Intercostal cells axially elongated, thin-walled, sinuous with straight end walls. Stomata (L. 32-36 μ; W. 24 μ); subsidiary cells low dome-shaped; interstomatal cells short to moderately long with straight end walls. Yellowish granular conglomerate type of silica-bodies present as in *S. corymbosa* (Pl. 8, N); silica-cells short, narrow, thin-walled, occurring in 2-3 continuous rows, each cell containing 2-3 (-4) cone-shaped silica-bodies surrounded by satellites. Hooks (L. 80 μ), exceedingly thick-walled, pointed, rigid with lamellations present on the margin (Pl. 8, F).

Adaxial surface: Cells broad, hexagonal, thin-walled, smooth. Cells over the costa containing cone-shaped silica-bodies surrounded by satellites. Intercostal cells short, oblong, each containing few to many smaller silica-bodies (Pl. 8, B). End walls of cells overlaid with abundant dome-shaped or hemispherical echinulate silica-bodies (Pl. 9, H).

Lamina, transverse section: Outline somewhat inversely W-shaped as in Pl. 8, A. Keel broadly triangular, rounded. Margin obtuse. Bulliform cells in groups of 7, fan-shaped (Pl. 8, A). Sclerenchyma girders (abaxial: Ht. 16-20 μ; W. 28-56 μ), crescent-shaped; adaxial strands (Ht. 32 μ; W. 40 μ), pulviniform. Bundle sheaths double: O.S. incomplete, I.S. complete.

CULM. *Epidermis, surface view.* Cells rather short, thin-walled, smooth. Stomata (L. 36-40 μ; W. 24-28 μ); subsidiary cells parallel-sided; interstomatal cells, see leaf. Silica-cells over the peripheral sclerenchyma strands short, broad, thin-walled, smooth, occurring in 3-4 continuous files, each containing 2-3 (-4) large, nodular silica-bodies (Pl. 8, M); outer surface of the cells characterized by 2-3 dome-shaped papillae, each one of them possessing single medium size silica-body (Pl. 8, I); smaller and echinulate silica-bodies, see leaf.

Transverse section: Outline acutely triangular (Pl. 10, A). Epidermal cells slightly thick-walled, broad. Ground tissue parenchymatous tending to become lysigenous air-cavities. Sclerenchyma girders (Ht. 24-40 μ; W. 60-112 μ), see leaf. Vb's 11 in number belonging to type III A, all forming a regular peripheral ring (Pl. 10, A). Bundle sheaths see leaf. Metaphloem of " intermediate type ".



Pl. 8. — **Scleria caricina** : **A**, Part of lamina, ground plan (× 90); **B**, Surface view of adaxial epidermal cell (× 450); **F**, Marginal hook (× 350); **H**, End walls of abaxial epidermal cells (silica-bodies stippled) (× 490); **I**, **M**, Culm epidermal cells, surface view (× 450). — **S. corymbosa** : **C**, Part of lamina, ground plan (× 30); **D**, T. S. leaf margin (× 30); **E**, T. S. leaf, ground plan (diagrammatic); **N**, Abaxial surface (× 350). — **S. sumatrensis** : **G**, T. S. mid region of leaf (× 115); **K**, T. S. leaf, ground plan (diagrammatic); **L**, T. S. leaf margin (× 115). — **S. lithosperma** var. **lithosperma** : **J**, marginal prickle (× 450) (S.P. = silica particle). — **S. lithosperma** var. **linearis** : **O**, Abaxial surface (× 350). — **S. lithosperma** var. **muricata** : **P**, Part of lamina (× 190). — **S. lithosperma** var. **multispiculata** : **Q**, Surface view of stoma and silica deposits (× 450).

MATERIAL EXAMINED: Herb. No. 1946, Kambakkam, Nellore Dt.; *Fyson 3342*, Anamalais, Combatore Dt.

Scleria corymbosa Roxb.

LEAF. *Abaxial surface:* Intercostal cells moderately long, broadly hexagonal, thick-walled, smooth; end walls frequently overlaid with dome-shaped or hemispherical warty or echinulate silica-bodies as in *S. caricina* (Pl. g, H). Stomata (L. 44-52 μ; W. 40-44 μ); subsidiary cells tall dome-shaped; interstomatal cells short. Silica cells short, narrow, thin-walled occurring in 6-g (-10) uninterrupted rows, each cell possessing 1-2 cone-shaped silica-bodies surrounded by satellites; each interstomatal and intercostal cell containing 2-3 cone-shaped silica-bodies arranged in 1-2 rows in each cell also common; intercostal cells sometimes containing single conglomerate type of silica-body per cell (Pl. 8, N).

Adaxial surface: Cells short comprising both cubical and hexagonal cells; cell walls thick, smooth; end walls containing silica-bodies as described for abaxial surface. Cells over the costa short, narrow, thin-walled, sinuous, present in 1-2 discontinuous rows, each cell containing cone-shaped silica-bodies as described for abaxial surface; conglomerate type of silica-body, see abaxial surface.

Lamina, transverse section: Outline inversely W-shaped as in Pl. g, $\overline{E}$; keel conspicuous, rounded (Pl. g, C); margin acute (Pl. g, D). Cuticle thin. Bulliform cells in groups of 13, very large, inflated forming a regular group (Pl. g, C). Sclerenchyma strands (adaxial: Ht. 32-56 μ; W. 6g-gg μ; keel: Ht. 56-60 μ; W. 1g0-200 μ), pulviniform; abaxial sclerenchyma girders (Ht. 64-72 μ; W. 60-120 μ), pulviniform (Pl. g, C); circumvascular sclerenchyma forming adaxial cap to the median keel bundle (Pl. 8, C). Vb's 53 in number, not showing regular alternation. Bundle sheaths double: O.S. parenchymatous, incomplete; I.S. sclerenchymatous; O.S. of the large and medium bundles incomplete, I.S. complete; both complete in the smaller bundles. Mesophyll, vb's tannin idioblasts, see common characters.

CULM. *Epidermis, surface view:* Cells variable in shape and size (short and long, cubical or hexagonal); walls exceedingly thick characterized by narrow, angular lumina (Pl. 10, C). Stomata not observed. Silica-cells over the sclerenchyma girders, short, narrow, exceedingly thick-walled, occurring in 1-2 discontinuous rows, each cell possessing 2-6 small cone-shaped silica-bodies without satellites.

Transverse section: Outline triangular with concave sides as in Pl. 10, H. Cuticle undulate (Pl. 10, F). Epidermal cells exceedingly thick-walled. Hypodermis consisting of 1-2 layers of sclerenchyma throughout except at the corners; brachysclereids present at the corners (Pl. 10, H). Ground tissue lacunose containing large number of air-cavities. Vb's many and of three sizes; medium and small bundles forming a peripheral ring; large

bundles scattered in the ground tissue (Pl. 10, H). Circumvascular sclerenchyma crescentiform present in all the bundles. Bundle sheaths double: O.S. parenchymatous, I.S. sclerenchymatous; in the peripheral bundles, O.S. incomplete, I.S. complete; in the central bundles both complete; bundles at the corners possessing single-layered sclerenchymatous sheath, complete; smaller bundles belonging to type I, medium and large bundles to type III B, the latter containing protoxylem lacunae. Vessel members (D. 112-120 μ in diameter). Sclerenchyma girders (Ht. 48-108 μ; W. 100-160 μ), crescentiform (T-shaped). Metaphloem, tannin idioblasts, see leaf.

SHEATH. *Epidermis, surface view:* Cells cubical; walls very thick, conspicuously sinuous. Stomata (L. & W. 48 μ); subsidiary cells triangular; interstomatal cells short; stomata frequently ensheathed by silica deposits. Silica-cells over the peripheral sclerenchyma girders short, narrow, thick-walled, sinuous, present in 3-6 continuous rows, each cell containing 1-2 cone-shaped silica-bodies without satellites and few cells containing particulate silica-bodies.

Transverse section: Cuticle, epidermal cells, see culm; epidermal cells overlaid with silica deposition. Ground tissue parenchymatous. Air-cavities containing lobed parenchyma and alternating with vb's. Vb's many, belonging to type III A forming a single row subjacent to abaxial surface, sometimes small bundles of type I also present. Vessel members (D. 28-32 μ in diameter). Metaphloem, bundle sheathss, circumvascular sclerenchyma and tannin idioblasts, see culm. Sclerenchyma girders (Ht. 40-60 μ; W. 80-140 μ), crescentiform (rectangular).

RHIZOME. *Transverse section:* Diameter of the rhizome examined 4.9 mm. Epidermis: cells variable possessing suberized, thick walls. Hypodermis consisting of large, compactly arranged parenchyma cells. Cortex: outer consisting of 10-12 layers of sclerenchyma, inner constituted of lobed parenchyma cells; inner cortex delimited by 2-3 layers of sclerenchyma. Vb's many, scattered. Bundle sheaths double: O.S. parenchymatous, I.S. sclerenchymatous, both complete. Vessel members (D. 20-24 μ in diameter).

ROOT. *Transverse section:* Diameter of the root examined *ca.* 2.0 mm. Epidermis: cells 3-4 layered; walls thick, suberized. Cortex: outer cortex, see common characters; inner consisting of 3-5 layers of sclerenchyma arranged radially in alignment with endodermal cells. Endodermal cells more or less isodiametric, characterized by uniformly thickened walls and broad lumina. Pericycle parenchymatous. Metaxylem elements occurring in 8 units. Protoxylem units 16 in number. Vessel members (D. 88-92 μ in diameter). Metaphloem conspicuous alternating with as many protoxylem units and each unit of metaphloem consisting of 3-6 large sieve tube elements and 4-8 companion cells. Central ground tissue sclerenchymatous.

MATERIAL EXAMINED: *Govindarajalu & Swamy 3782*, Nagari, Chittoor Dt.; *Go. 5959*, Nagari, Chittoor Dt.; *Ramamurthy s.n.*, Parambikulam, Kerala state; *Rangarajan 9098* Nagari, Chittoor Dt.

Scleria levis Retz.

LEAF. *Abaxial surface:* Intercostal cells variable in size and shape (moderatley long to short, cubical or somewhat hexagonal), thick-walled, moderatley broad, more or less sinuous with convex end walls. Stomata (L. & W. 28 μ); subsidiary cells triangular; interstomatal cells short. Silica-cells long, narrow, thin-walled occurring in 3 (-4) continuous rows, each cell possessing 4-7 cone-shaped silica-bodies without satellites. Macrohairs (L. (60-) 120-160 μ), thick-walled, pointed present in the intercostal regions.

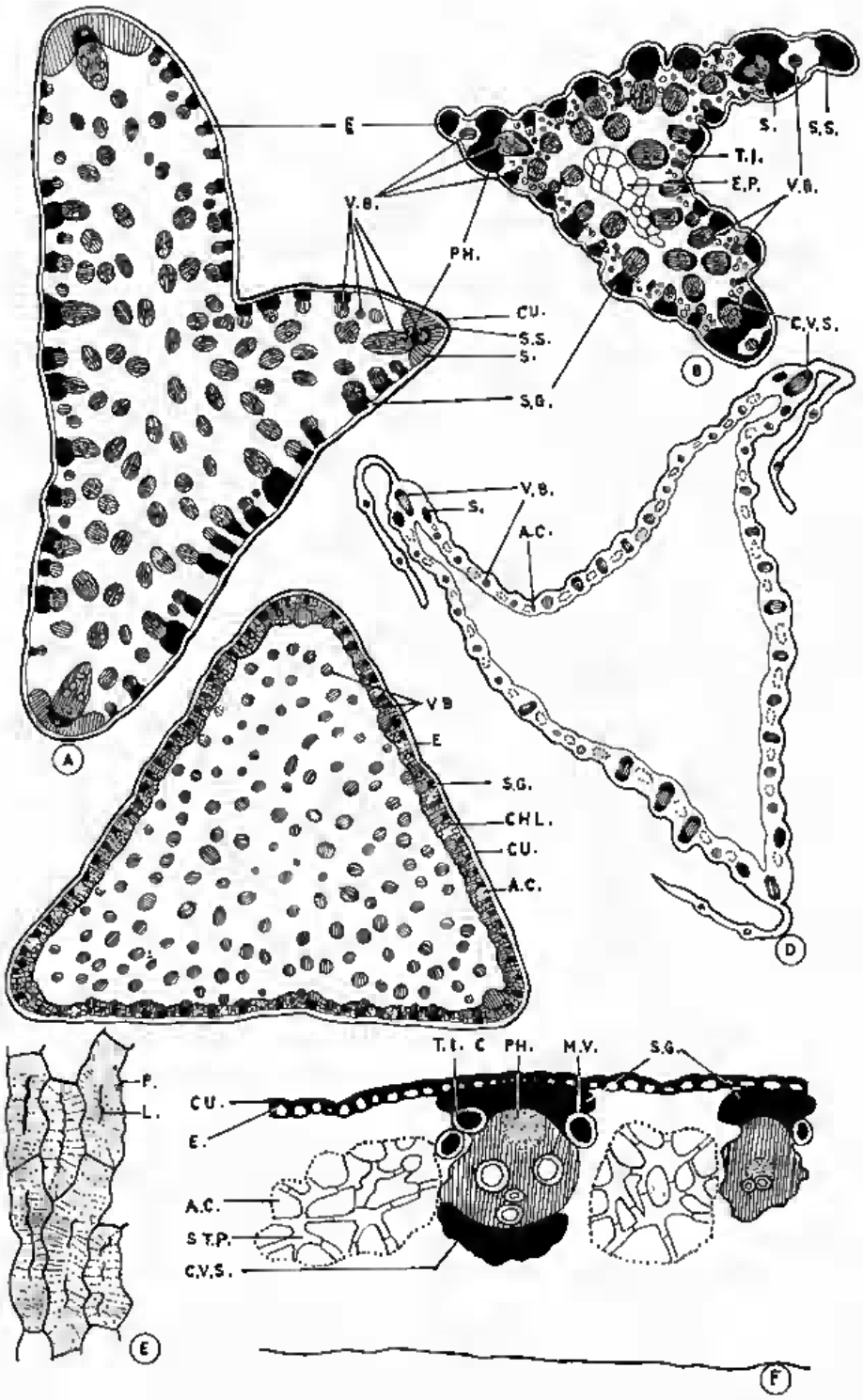
Adaxial surface: Cells as described for abaxial surface but the end walls straight. Silica-cells over the costa narrow, thin-walled, smooth, occurring in 2-3 continuous rows, each cell containing 8-14 particulate silica-bodies.

Lamina, transverse section: Outline inversely W-shaped as in *S. corymbosa* (Pl. 8, E). Epidermal cells overlaid with silica particles. Keel triangular, pointed. Bulliform cells in groups of 7, see *R. corymbosa*. Sclerenchyma girders (Ht. & W. 28-60 μ) pulviniform, occurring on both surfaces. Vb's 33 in number. Bundle sheaths, see *S. corymbosa*.

CULM. *Epidermis, surface view:* Cells long; walls very thick, sinuous, pitted-possessing narrow slit like lumina; each cell containing 2-6 (-8) particulate silica-bodies (Pl. 10, B); end walls oblique to overlapping; saddle-shaped, oblong or acutely angled silica-bodies sometimes present in the sinuosities of the cells. Stomata (L. & W. 32-34 μ); subsidiary cells, see leaf; interstomatal cells long; stomata rarely infiltrated with and modified by silica deposition (Pl. 10, D).

Transverse section: Outline triangular with concave sides as in *S. corymbosa* (Pl. 10, H). Epidermal cells very thick-walled with narrow lumina. Wedge-shaped silica-bodies seen within the sinuosities of the cells. Hypodermis absent on the lateral sides; multiple-layered sclerenchyma present at the corners; brachysclereids less common, see *S. corymbosa*. Cells of inner sheath containing a single green silica-body per cell. Vessel members (D. 52-60 μ in diameter). Sclerenchyma girders (Ht. 36-64 μ; W. 80-100 μ), rectangular to triangular.

SHEATH. *Epidermis, surface view:* Cells short, variable in size, moderately thick-walled, sinuous; end walls straight or overlapping. Stomata (L. 32-40 μ; W. 28-32 μ); subsidiary and interstomatal cells, see leaf. Silica-cells overlying the peripheral sclerenchyma girders short or long, thin-walled, smooth, narrow present in 2-3 continuous rows, each cells containing 2-3 cone-shaped silica-bodies without satellites; cells



Pl. 9. — **S. poæformis** : A, T. S. culm, ground plan (× 20). — **S. tessellata** : B, T. S. culm, ground plan (× 50). — **S. sumatrensis** : C, T. S. culm, ground plan (× 22); E, Surface view of sheath epidermis (× 450); F, T. S. part of sheath (× 190). — **S. levis** : D, T. S. sheath, ground plan (× 35).

containing several particulate, cone-shaped silica-bodies also common. Macrohairs, see leaf. Angular prickles (L. 120-128 μ) over the costa pointed, rigid, thick-walled.

Transverse section: Outline triquetrous with wing-like extensions at the corners (Pl. 9, D). Abaxial epidermal cells smaller than those of the adaxial; cells thick-walled and overlaid with thick cuticle on either surface. Air-cavities regularly alternating with vb's (Pl. 9, D), each containing lobed parenchymatous cells. Vb's 45 in number belonging to type III A and type I (Pl. 9, D). Bundle sheaths single, sclerenchymatous, complete. Circumvascular sclerenchyma 3-4-layered, deeply crescentiform forming an inner cap to all the bundles. Sclerenchyma girders (Ht. 20-28 μ; W. 44-60 μ), pulviniform to crescentiform, uniting with circumvascular sclerenchyma of the bundles thus forming a complete sheath to every bundle. Metaphloem not easily recognizable. Macrohairs (L. 160-200 μ) present on the abaxial surface, see leaf.

RHIZOME. *Transverse section:* Diameter of the rhizome examined 9.1 mm. Epidermis: cells thin-walled. Cortex broad, parenchymatous occurring in two zones: outer containing colourless cells, inner comprising cells with unknown contents. Vb's many, scattered; peripheral bundles smaller than those of the central bundles. Vascular regions delimited by 4-6 layers of sclerenchyma. Fibrous bundles also present. Vessel members (D. 16-20 μ in diameter).

ROOT. *Transverse section:* Diameter of the root examined 0.9 mm. Exodermis, cortex, see *S. corymbosa*. Endodermis constituted of radially elongated cells, see *S. corymbosa*. Metaxylem units 8 in number, peripheral surrounding a single solitary central larger element. Vessel members (D. 100 μ in diameter). Protoxylem units 13. Pericycle, metaphloem, tannin idioblasts, see *S. corymbosa*.

MATERIAL EXAMINED: *Govindarajalu 6024, 6025*, Orukomban, Kerala state; *Go. 6051, 6052, 6064*, Anakayam, Kerala state; *Go. 6466*, Cheriakanam, Kerala state; *Go. 7650*, Panthadikalam, Kanyakumari Dt.; *Go. 7767*, Kalikesam, Kanyakumari Dt.; *Go. 8011*, Kambakkam, Nellore Dt.; *Sedgwick 3166*, N. Kanara.

Scleria lithosperma (L.) Sw. var. **lithosperma**

LEAF. *Abaxial surface:* Intercostal cells moderately long, thick-walled, sinuous with straight end walls; end walls overlaid with echinulate silica-bodies, see *S. caricina* (Pl. 8, H). Stomata (L. & W. 24 μ); subsidiary cells parallel sided; interstomatal cells moderately long. Silica-cells over the costa short, narrow, thin-walled, smooth, occurring in 2-3 (-4) continuous rows, each cell possessing 1-2 (-4) cone shaped silica-bodies without satellites. Angular prickles (L. 64-68 μ), thick-walled, pointed, rigid present in the margin and filled with silica particles (Pl. 8, J).

Adaxial surface: Cells usually short; walls very thick, smooth, pitted; end walls straight and containing echinulate silica-bodies as in *S. caricina* (Pl. 8, H); cells possessing conglomerate silica-bodies also common as in *S. corymbosa* (Pl. 8, N). Silica-cells in the costal region present in 6-8 continuous rows, each one of them developing silica-bodies as described for abaxial surface. Stomata (L. 36 μ; W. 24 μ); stomata in the submarginal region modified due to the deposition of silica material. Angular prickles present in the marginal and submarginal regions, see abaxial surface.

Lamina, transverse section: Outline inversely W-shaped as in *S. corymbosa* (Pl. 8, E); keel, margin, see *S. corymbosa* (Pl. 8, C, D). Epidermal surface covered with silica material. Substomatal chamber very narrow. Bulliform cells in regular fan-shaped groups of 9. Sclerenchyma girders (abaxial: Ht. 8-16 μ; W. 32-68 μ), deeply crescentiform; sclerenchyma strands (adaxial: Ht. 20-40 μ; W. 24-40 μ), pulviniform. Circumvascular sclerenchyma absent. Mesophyll, see *S. corymbosa.* Vb's 27 in number comprising large and small bundles, not regularly alternating with each other. Bundle sheaths double: O.S. incomplete, I.S. complete.

CULM. *Epidermis, surface view:* Cells moderately long; walls very thick, pitted, smooth; end walls straight. Stomata (L. 24 μ; W. 16 μ); subsidiary and interstomatal cells, see leaf; stomata frequently surrounded by and infiltrated with silica material. Silica-cells over the peripheral sclerenchyma girders, narrow, short, thin-walled, sinuous, occurring in 4-5 (-6) continuous files, each cell containing 1-2 (-3) cone-shaped-silica-bodies without satellites. Angular prickles, see leaf. Macrohairs (L. 280-300 μ), thick-walled, pointed.

Transverse section: Outline triangular with concave sides (Pl. 10, K). Epidermis: cells moderately thick-walled, papillate; wedge-shaped silica-bodies present in the sinuosities of the cells. Hypodermis absent. Ground tissue consisting of compactly arranged parenchyma. Vb's 36-38 in number, see *S. corymbosa.* Circumvascular sclerenchyma, bundle sheaths, bundle types, see *S. corymbosa.* Vessel members (D. 24-28 μ in diameter). Sclerenchyma girders (Ht. 24-48 μ; W. 64-80 μ), rectangular to crescentiform. Cells of inner bundle sheaths and girders sometimes containing green silica-bodies.

SHEATH. *Epidermis, surface view:* Cells usually short, hexagonal, thin-walled, sinuous with straight end walls. Stomata (L. 20-28 μ; W. 20-24 μ); subsidiary cells, see culm; interstomatal cells short. Silica-cells over the peripheral sclerenchyma girders long or short, narrow, thin-walled, sinuous occurring in 1-2 continuous rows, each cell having cone-shaped silica-bodies as in culm; few smaller silica-bodies in cells sometimes present. Macrohairs (L. 500-520 μ), thick-walled, pointed, abundant in the intercostal regions.

Transverse section: Epidermis: abaxial rather larger than adaxial cells wedge-shaped silica-bodies in the sinuosities of abaxial cells. Ground tissue: 4-6 compact layers of chlorenchyma. Air-cavities absent. Vb's many, arranged in a row next to abaxial surface. Vessel members (D. 16-20 μ in diameter). Circumvascular sclerenchyma forming an inner cap to all the large bundles. Metaphloem, see *S. corymbosa*. Bundle sheaths: double, O.S. incomplete, I.S. complete. Sclerenchyma: girders (Ht. 40-64 μ; W. 80-140 μ), pulviniform or crescentiform; abaxial strands on either side of keel bundle (Ht. 40-48 μ; W. 64-72 μ), pulviniform.

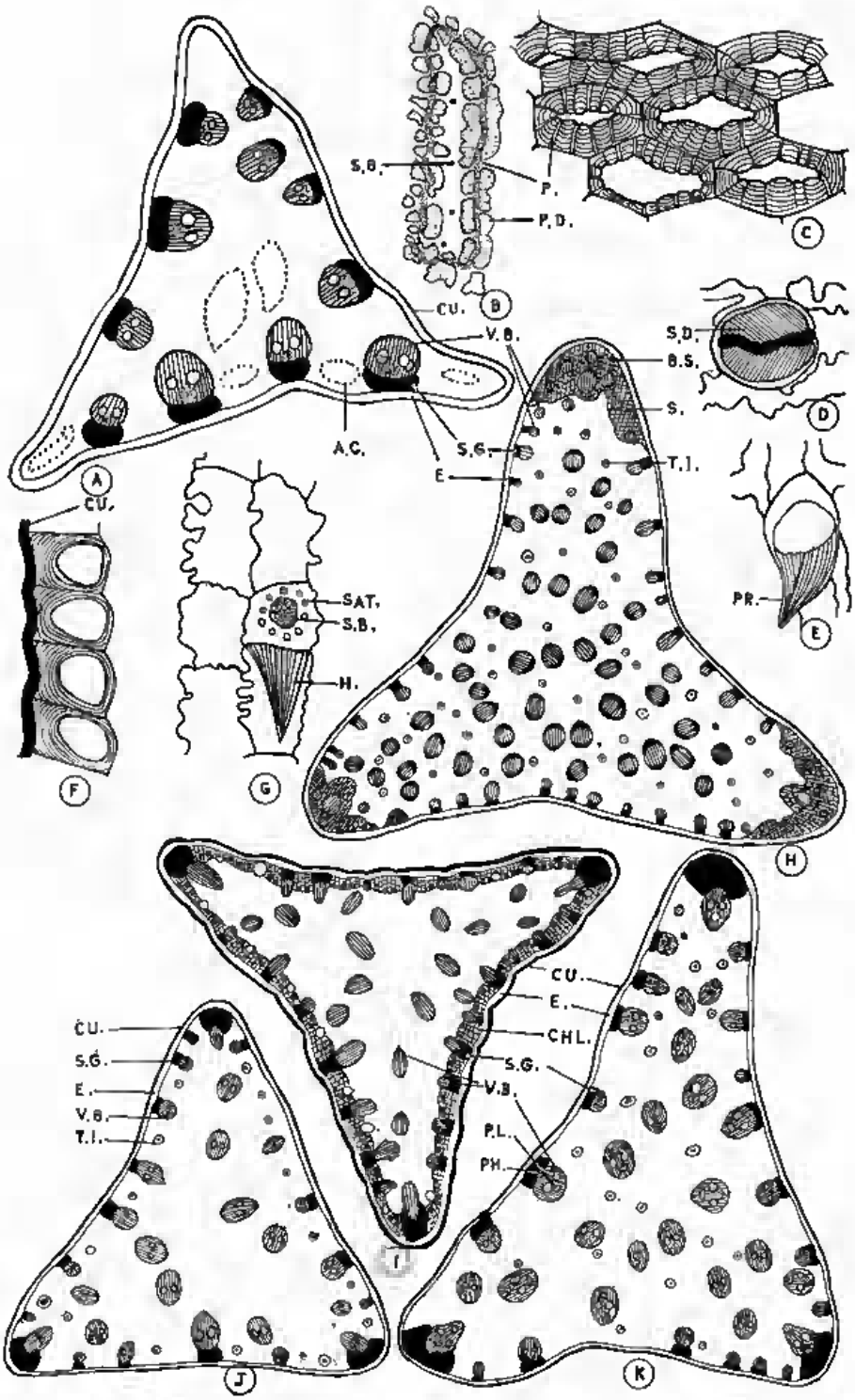
RHIZOME. *Transverse section:* Diameter of the rhizome examined 3.5 mm. Epidermis: cells moderately thick-walled, rectangular. Sclerenchyma strands (Ht. 40 μ; W. 40-48 μ), more or less rounded present next to epidermis. Cortex: rather broad, parenchymatous containing 6-8 layers of compactly arranged brachysclereids and the latter occurring in discontinuous groups; brachysclereid cells characterized by narrow lumina and ramiform pits. Endodermis: conspicuous, constituted of uniformly thickened cells having circular lumina. Vb's many, the peripheral bundles forming a ring; bundle size progressively increasing from the periphery towards centre; peripheral bundles oval-shaped while the central bundles circular in outline and scattered. Vessel members (D. 12-16 μ in diameter). Metaphloem of peripheral bundles not easily distinguishable while that of the central bundles well developed.

ROOT. *Transverse section:* Diameter of the root examined 0.75 mm. Exodermis: cells thick-walled, isodiametric. Cortex: inner cortex consisting of 2 layers of sclerenchyma arranged in radial alignment with endodermal cells. Endodermis: conspicuous, cells radially elongated and having uniform thickening. Pericycle indistinct. Central ground tissue sclerenchymatous. Metaxylem element solitary and central. Vessel members (D. 80 μ in diameter). Protoxylem units 15. Metaphloem occurring in 15 units, each unit consisting of 1-2 large sieve tube elements and 2-3 sclerosed companion cells.

MATERIAL EXAMINED: *Ernest Thayasingh 137*, Pechiparai, Kanyakumari Dt.; *Govin, darajalu 5958*, Nagari, Chittoor Dt., *Go. 6120*, Orukomban, Kerala state; *Go. 6426*, Guindy, Madras; *Go. 7357*, Kilaviyar, Kanyakumari Dt.; *Go. 8010*, Kambakkam-Nellore Dt.; *Krishnamurthy 92*, Kiriparai, Kanyakumari Dt.; *Sedgwick 5069*, Karwar; *Vasudeva Rao, 9138*, Kambakkam, Nellore Dt.

Scleria lithosperma var. **linearis** Benth.

LEAF. *Abaxial surface:* Intercostal cells axially elongated, narrow, thin-walled, moderately sinuous; end walls straight; end and lateral walls overlaid with conspicuous echinulate dome-shaped or hemispherical silica-bodies (Pl. 8, O). Stomata (L. 24 μ; W. 20 μ); subsidiary and interstomatal cells, see *S. lithosperma* var. *lithosperma;* stomata surrounded by and infiltrated with silica material also commonly present. Silica-cells over



Pl. 10. — **S. caricina** : A, T. S. culm, ground plan (× 75). — **S. levis** : B, Surface view of culm epidermal cell (× 450); D, Stoma, surface view (× 450). — **S. corymbosa** : C, Surface view of culm epidermis (× 350); F, T. S. culm epidermis (× 350); H, T. S. culm, ground plan (× 22). — **S. poæformis** : E, Hook, surface view (× 450). — **S. sumatrensis** : G, Surface view of culm epidermis (× 450). — **S. lithosperma** var. **muricata** : I, T. S. culm, ground plan (× 35). — **S. lithosperma** var. **multispiculata** : J, T. S. culm, ground plan (× 50). — **S. lithosperma** var. **lithosperma** : K, T. S. culm, ground plan (× 50).

the costa, see *S. lithosperma* var. *lithosperma*; longer silica-cells containing 6-8 smaller silica-bodies also present. Angular prickles (L. 80-88 μ), devoid of contents, see *S. lithosperma* var. *lithosperma*.

Adaxial surface: Cells short, isodiametric or oblong; walls thick, smooth; end and lateral walls containing silica-bodies as described for abaxial surface. Conglomerate type of silica-bodies 1 per cell rarely present. Hooks (L. 24 μ) over the costa rigid, sharp, almost without lumina. Silica-cells over the costa, narrow, moderately long (short), thick-walled, smooth, occurring in 1-2 continuous rows, each cell possessing silica-bodies as in abaxial surface; particulate type of silica-bodies also common.

Lamina, transverse section: Outline inversely W-shaped as in *S. corymbosa* (Pl. 8, E). Abaxial epidermal cells somewhat papillate, thin-walled; keel, substomatal chamber, see *S. lithosperma* var. *lithosperma*. Margins obtuse. Bulliform cells in groups of 5, see *S. lithosperma* var. *lithosperma*. Sclerenchyma girders (abaxial: Ht. 12-16 μ; W. 25-60 μ); adaxial strands (Ht. & W. 40-44 μ). Circumvascular sclerenchyma, mesophyll, see *S. lithosperma* var. *lithosperma*. Vb's 19 in number, see *S. lithosperma* var. *lithosperma*. Bundle sheaths, see *S. lithosperma* var. *lithosperma*.

CULM. *Epidermis: surface view:* Cells short or moderately long, narrow, exceedingly thick-walled, smooth, pitted with straight end walls. Stomata (L. & W. 28 μ), not common; subsidiary cells low dome-shaped; interstomatal cells long; stomata commonly infiltrated with silica material. Silica-cells over the peripheral sclerenchyma girders long, narrow, thin-walled, sinuous, occurring in 4-6 continuous rows, each cell containing (3-) 4-6 cone-shaped silica-bodies without satellites.

Transverse section: Outline triangular with concave sides as in *S. lithosperma* var. *lithosperma* (Pl. 10, K). Cuticle very thick. Epidermal cells exceedingly thick-walled, smooth with very narrow lumina; sinuosities of the cells containing wedge-shaped silica-bodies. Ground tissue compact, parenchymatous. Vb's 26 in number, all being more or less of the same size; bundles in the periphery forming a regular ring and those in the centre scattered. Vessel members (D. 20-28 μ in diameter). Sclerenchyma girders (Ht. 44-60 μ; W. 80-100 μ), rectangular to crescentiform. Other details as in *S. lithosperma* var. *lithosperma*.

SHEATH. *Epidermis: surface view:* Cells short, variable in shape, thick-walled moderately sinuous, pitted with straight end walls. Stomata (L. & W. 20-24 μ), usually surrounded by and infiltrated with silica material; subsidiary cells low dome-shaped; interstomatal cells short. Hooks (L. 52-60 μ) in the intercostal regions thick-walled, pointed, rigid. Macrohairs, see *S. lithosperma* var. *lithosperma*. Silica-cells over the peripheral sclerenchyma girders short, narrow, thick-walled, smooth, present in 2-3 (-4) almost uninterrupted rows, each cell possessing 2-3 cone-shaped silica-

bodies without satellites; intercostal cells sometimes containing silica particles.

Transverse section: Cells walls very thick. Abaxial and adaxial epidermal cells more or less of same size; sinuosities free from wedge-shaped silica-bodies. Ground tissue compact, containing colourless cells. Air-cavities absent. Vb's, circumvascular sclerenchyma, bundle sheaths as in *S. lithosperma* var. *lithosperma*. Vessel members (D. 12 μ in diameter). Sclerenchyma girders (Ht. 20-32 μ; W. 60-64 μ), see *S. lithosperma* var. *lithosperma;* abaxial strands (Ht. 24-40 μ; W. 36-48 μ) pulviniform with smooth or angular sides.

ROOT. *Transverse section:* Diameter of the root examined 0.7 mm. Exodermis: cells variable, thin-walled. Cortex, see *S. lithosperma* var. *lithosperma*. Endodermis conspicuous; cells radially elongated, wedge-shaped with lamellated thickenings and narrow lumina. Pericycle sclerenchymatous. Central ground tissue sclerenchymatous. Metaxylem large, central, solitary. Vessel members (D. 52 μ in diameter). Protoxylem units 9. Metaphloem conspicuous, containing 9 units, each unit containing one large sieve tube element and 4-6 companion cells.

MATERIAL EXAMINED: *Govindarajalu 7249*, Guindly Park, Madras; *Go. & Swamy 2265*, Kodamadi, Tirunelveli Dt.; *Lakshmi 243*, Courtallam, Tirunelveli Dt.; *Murugesan & Subramaniam 8613*, Courtallam, Tirunelveli Dt.; *Rajasekaran 92*, Kodamadi, Tirunelveli Dt.

Scleria lithosperma var. **multispiculata** Govindarajalu

LEAF. *Abaxial surface:* Intercostal cells moderately long, thin-walled, rather broad, sinuous with straight end walls; end walls very commonly having 1-4 dome-shaped or hemispherical, large, greenish, smooth silica-bodies (Pl. 8, Q); conglomerate type of silica-bodies also common in certain cells. Stomata (L. 32 μ; W. 28 μ); subsidiary cells triangular; interstomatal cells short; stomata quite frequently possessing dome-shaped greenish silica deposits at the poles (Pl. 8, 2) or assuming curious pattern of development and distribution surrounding the stomata; stomata usually impregnated with silica material. Silica-cells over the costa long, narrow, thin-walled, smooth occurring in 2 uninterrupted files, each cell having 5-6 small cone-shaped silica-bodies without satellites.

Adaxial surface: Epidermis: cells short, rectangular; walls thick, pitted, smooth; end walls straight; cells characterized by 1-3 dome-shaped papillae, each papilla enclosing a greenish silica-body as in *S. caricina* (Pl. 8, 1); few cells containing 1-2 spherical greenish silica-bodies occasionally present; conglomerate type of silica-bodies 1-2 (-3) per cell common. Silica-cells over the costa moderately long or short, narrow, thin-walled, smooth, present in 1-2 interrupted files, each cell containing 1-2 (-3) cone-shaped silica-bodies without satellites; particulate type of silica-bodies occasionally present in the intercostal cells. Angular hooks (L. 80-88 μ)

present over the submarginal costae. Stomata (L. 32-36 μ; W. 24-28 μ); subsidiary cells low dome-shaped; interstomatal cells short with concave ends; stomata often surrounded by and filled with silica material exhibiting abnormal forms.

Lamina, transverse section: Outline inversely W-shaped as in *S. corymbosa* (Pl. 8, E). Epidermis, substomatal chambers, see *S. lithosperma* var. *lithosperma*. Keel triangular, pointed. Margins obtuse with adaxial submarginal rib. Bulliform cells in groups of 7, see *S. lithosperma* var. *lithosperma*. Sclerenchyma girders (abaxial & adaxial marginal; Ht. 12-36 μ; W. 48-100 μ) usually rectangular; adaxial strands (Ht. 36-60 μ; W. 140 μ) pulviniform or crescentiform. Vb's 32 in number comprising large (type III B), medium (type III A) and small bundles (type I) not showing regular alternation. Bundle sheaths double: O.S. incomplete, I.S. complete; O.S. and I.S. of smaller bundles complete. Other details as in *S. lithosperma* var. *lithosperma*.

CULM. *Epidermis, surface view:* Cells long; walls very thick, pitted, sinuous; end walls straight. Stomata (L. 28 μ; W. 24 μ), not common; subsidiary cells parallel-sided; interstomatal cells long. Silica-cells overlying the peripheral sclerenchyma girders long, narrow, thick-walled, slightly sinuous, occurring in 4-6 continuous rows, each cell possessing 3-4 (-5) cone-shaped silica-bodies without satellites.

Transverse section: Outline triangular with somewhat concave sides as in Fig. 11, J. Cuticle thin. Epidermis: cells thin-walled, smooth; silica-bodies absent in the sinuosities of the cells. Vb's 31 in number, see *S. corymbosa*. Circumvascular sclerenchyma, bundle sheaths, see *S. corymbosa*. Vessel members (D. 20-24 μ in diameter). Sclerenchyma girders (Ht. 8-28 μ; W. 52-128 μ) and other details see *S. lithosperma* var. *lithosperma*.

SHEATH. *Epidermis, surface view:* Cells moderately long and short, somewhat hexagonal, broad; walls moderately thick, sinuous, pitted; end walls straight. Stomata (L. 24-28 μ; W. 36 μ); subsidiary cells tall or low dome-shaped; interstomatal cells short; stomata rarely surrounded by and infiltrated with silica materials; end walls sometimes containing silica-bodies, see leaf. Silica-cells over the peripheral sclerenchyma girders, long, narrow, thin-walled, smooth, occurring in 3-5 continuous rows, each cell containing 3-4 (-5) cone-shaped silica-bodies without satellites. Hooks (L. 32-60 μ) pointed, thick-walled, rigid, abundantly present in the intercostal regions. Macrohairs (L. 360-372 μ) also present in the intercostal regions.

Transverse section: Vessel members (D. 16 μ in diameter). Circumvascular sclerenchyma forming an inner cap to large and small bundles. Sclerenchyma girders (Ht. 16-40 μ; W. 40-100 μ) and those in the keel (Ht. 100-120 μ; W. 140-148 μ). Other details as in *S. lithosperma* var. *lithosperma*.

ROOT. *Transverse section:* Diameter of the root examined 1.5 mm. Endodermal cells exceedingly thick-walled, without lumina. Vessel members (D. 60 μ in diameter). Protoxylem units 16. Metaphloem occurring in 16 units. Other details as in *S. lithosperma* var. *lithosperma.*

MATERIAL EXAMINED: *Govindarajalu 7768*, Kanyakumari Dt. (*Type*).

Scleria lithosperma var. **muricata** Govindarajalu

LEAF. *Abaxial surface:* Intercostal cells short, variable; cell walls very thick, rather broad, smooth; end walls straight containing abundant echinulate or warty dome-shaped or hemispherical silica-bodies as in *S. lithosperma* var. *limearis* (Pl. 8, O); conglomerate type of silica-bodies very common in each cell. Stomata (L. 32 μ; W. 20 μ); subsidiary cells low dome-shaped; interstomatal cells short with straight end walls; stomata filled with and surroudend by silica material common. Silica-cells over the costa short, narrow, thin-walled, smooth, occurring in 2-4 continuous rows, each cell containing 1-2 cone-shaped silica-bodies without satellites; nodular type of silica-bodies also present in some cells.

Adaxial surface: Cells short, oblong, very thick-walled, broad, smooth, with concave end walls; end walls containing silica-bodies occasional. Silica-bodies over the costa long or short, thick-walled, narrow, each cell having 2-4 cone-shaped silica-bodies without satellites. Conglomerate type of silica-bodies occasional.

Lamina, transverse section: Outline inversely W-shaped as in *S. corymbosa* (Pl. 8, E). Keel prominent, subtriangular. Margins obtuse. Bulliform cells in regular groups of 5. Hypodermis consisting of single layer of translucent cells and present subjacent to bulliform cells. Sclerenchyma strands (adaxial: Ht. 24-28 μ; W. 40-60 μ) pulviniform, smooth or with angular sides; sclerenchyma girders (abaxial: Ht. 16-48 μ; W. 24-80 μ) deeply crescentiform (adaxial: Ht. 80 μ; W. 120-128 μ); sub-T-shaped (Pl. 8, P). Mesophyll consisting of single layer of palisade. Vb's 41 in number, see *S. corymbosa.* Bundle sheaths single, sclerenchymatous, complete. Metaphloem of 'irregular' type. Tannin idioblasts also common in the adaxial epidermal cells (Pl. 8, P).

CULM. *Epidermis, surface view:* Cells long, thick-walled, rather broad, smooth, with straight end walls. Stomata (L. 28-32 μ; W. 20 μ); subsidiary cells low dome-shaped; interstomatal cells long. Silica-cells over the peripheral sclerenchyma girders short, narrow, thin-walled, present in 1-3 continuous rows, each cell containing (2-) 3 (-4) cone-shaped silica-bodies without satellites. Hooks (L. 32-80 μ), see *S. poæformis* (Pl. 10, E).

Transverse section: Outline acutely triangular as in Pl. 10, I. Epidermal cells thick-walled. Hypodermis: 2-layered; outer layer chlorenchymatous; inner layer comprising tannin idioblasts (Pl. 10, I). Ground

tissue compact, parenchymatous. Sclerenchyma girders (Ht. 16-44 μ; W. 40-64 μ), see *S. corymbosa;* those at the corners (Ht. 160 μ; W. 120-140 μ) crescentiform (Pl. 10, I). Vb's many, the peripheral bundles forming a regular ring; central bundles scattered (Pl. 10, I), see *S. corymbosa;* large bundles containing protoxylem lacunae. Vessel members (D. 16-20 μ in diameter). Circumvascular sclerenchyma forming inner and outer caps to smaller bundles. Other details as in *S. corymbosa.*

SHEATH. *Epidermis, surface view:* Cells short, broad, moderately thick-walled, sinuous, pitted with straight end walls. Stomata (L. 24-28 μ; W. 32 μ); subsidiary cells tall dome-shaped; interstomatal cells short. Silica-cells overlying the costa short, broad, thin-walled, smooth, present in 2-4 continuous rows, each cell containing 1-3 coe-snhaped silica-bodies without satellites. Angular prickles (40-) 120-140 μ; walls thick, pointed, rigid, abundantly scattered throughout.

Transverse section: Epidermal cells, see culm. Ground tissue parenchymatous, 4 (-5)-layered. Air-cavities small, containing lobed parenchyma. Vb's many, belonging to type III A; keel bundles of type III B; arrangement of bundles, see *S. corymbosa.* Vessel members (D. 20-24 μ in diameter). Metaphloem of 'regular' type. Bundle sheaths double: O.S. incomplete; I.S. complete. Circumvascular sclerenchyma 2-3-layered, forming inner caps. Sclerenchyma girders (Ht. 12-40 μ; W. 60-100 μ), crescentiform.

ROOT. *Transverse section:* See *S. lithosperma* var. *multispiculata.*

MATERIAL EXAMINED: *Krishnamurthy 9512,* Pallathadka, Kerala state (Type).

Scleria poæformis Retz.

LEAF. *Abaxial surface:* Intercostal cells axially elongated, hexagonal, thin-walled, smooth, broad with straight end walls. Stomata (L. 48-52 μ; W. 40 μ); subsidiary cells triangular; interstomatal cells short; stomata sometimes surrounded by and filled with silica materials. Silica-cells over the costa short, narrow, thin-walled, smooth, present in 4-6 uninterrupted rows, each cell having 2-4 cone-shaped silica-bodies surrounded by satellites; cells containing silica-bodies varying in size and number also occasionally present.

Adaxial surface: Cells broad, rectangular, moderately thick-walled, sinuous with straight end walls; end walls containing silica-bodies, see *S. lithosperma* var. *linearis* (Pl. 8, O). Conglomerate type of silica-bodies occasional.

Lamina, transverse section: Outline inversely W-shaped as in *S. corymbosa* (Pl. 8, E). Sclerenchyma strands (Ht. 24-32 μ; W. 56-64 μ); girders (Ht. 24-40 μ; W. 32-48 μ). Vb's 45 in number. Other details as in *S. corymbosa.*

CULM. *Epidermis, surface view:* Cells moderately long, rectangular; cells containing silica particles of varying sizes; dome-shaped papillae containing silica deposits common. Stomata not observed. Prickles (L. 100-160 μ), thick-walled, pointed, straight or curved, abundant. Hooks (L. 36-48 μ), thick-walled, pointed, with swollen bases abundant (Pl. 10, E).

Transverse section: Outline asymmetrically triangular (Pl. 9, A). Hypodermis absent. Brachysclereids at the corners absent. Ground tissue parenchymatous, compact. Vessel members (D. 40-60 μ in diameter). Sclerenchyma girders (Ht. 120-160 μ; W. 160-320 μ), variable (crescentiform, rectangular, triangular); sclerenchyma strands at the corners (Ht. 80-88 μ; W. 600-800 μ), crescentiform. Other details as in *S. corymbosa*.

SHEATH. *Epidermis, surface view:* Cells short, rather broad, thick-walled, sinuous, pitted, usually having oblique end walls. Stomata (L. & W. 32-40 μ); subsidiary and interstomatal cells, see leaf; stomata often filled with and ensheathed by silica material. Silica-cells, see leaf.

Transverse section: Cuticle ratber uneven. Abaxial epidermal cells exceedingly thick-walled; adaxial epidermis overlaid with silica material. Air-cavities large, as many as and regularly alternating with vb's and containing stellate parenchyma. Abaxial hypodermis of 2 layers of parenchyma usually containing tannin; adaxial hypodermis of a single layer of colourless cells. Vb's many, comprising large (type III A) and small bundles (type I), regularly alternating with each other; large bundles containing protoxylem lacunae. Vessel members (D. 32-40 μ in diameter). Bundle sheaths of large bundles; I.S. complete; O.S. incomplete; of small bundles, both complete. Circumvascular sclerenchyma forming outer and inner caps. Sclerenchyma girders confronting large bundles (Ht. 60-80 μ; W. 184-212 μ), crescentiform; girders opposite to small bundles absent. Metaphloem of 'regular' type.

MATERIAL EXAMINED: *Alamelu 486*, Sholayar, Kerala state; *Govindarajalu & Swamy 2907*, Sholayar, Kerala state; *Shanthi 455*, Sholayar, Kerala state.

Scleria sumatrensis Retz.

LEAF. *Abaxial surface:* Intercostal cells short, variable; walls very thick, pitted, smooth; end walls straight. Stomata (L. 44-48 μ; W. 20 μ); subsidiary cells parallel-sided; interstomatal cells short. Silica-cells over the costa short, broad, thin-walled, smooth occurring in 4-5 (-6) continuous rows, eacb cell having 2 (-3) cone-shaped silica-bodies surrounded by satellites. Hooks (L. 40-60 μ), thick-walled, pointed, rigid present over the costa.

Adaxial surface: Cells short, variable, see abaxial surface. Cells overlying the costa short, rather broad, thick-walled, smooth, pitted, occurring in 2-4 (-6) rows but cells devoid of silica-bodies. Hooks (L. 64-80 μ) with bulbous bases present over the costae, see *S. lithosperma* var.

linearis. Stomata (L. 40-48 μ; W. 32 μ); subsidiary cells triangular; interstomatal cells short; stomata usually filled with and sometimes surrounded by silica deposit.

Lamina, transverse section: Outline shallowly corrugate (Pl. 8, K). Keel inconspicuous, rounded (Pl. 8, G). Margins subacute to obtuse (Pl. 8, L). Substomatal chamber very small. Bulliform cells in regular groups of 14; cells very large, inflated (Pl. 8, G). Translucent cells forming single-layered subjacent to bulliform cells (Pl. 8, G). Sclerenchyma strands (abaxial & adaxial; Ht. 16-18 μ; W. 20-40 μ), pulviniform (Pl. 8, L); abaxial girders (Ht. 40-60 μ; W. 32-100 μ), securiform (Pl. 8, G, L); adaxial girders (marginal & submarginal: Ht. 80-160 μ; W. 60-176 μ), pulviniform (Pl. 8, L); cells of the girders containing silica-bodies. Circumvascular sclerenchyma 1-4-layered forming an inner cap to bundles. Mesophyll consisting of 2 layers of palisade and several layers of spongy chlorenchyma. Vb's 10 in number. Tannin idioblasts abundant (Pl. 8, L). Other details as in *S. corymbosa*.

CULM. *Epidermis, surface view:* Cells short, tbin-walled, conspicuously sinuous (Pl. 10, G) with straight or oblique end walls; end walls containing dome-shaped or hemispherical smooth silica-bodies occasionally present. Silica-cells over the peripheral sclerenchyma girders short, narrow, thin-walled, conspicuously sinuous, present in 1-2 discontinuous rows, each cell containing 1-2 cone-shaped silica-bodies without satellites; conglomerate type of silica-bodies rare. Hooks (L. 40-64 μ), sharp, thick-walled; single cone-sbaped silica-body surrounded by satellites present in each basal cell (Pl. 10, G). Stomata (L. 36-40 μ; W. 24-28 μ), usually filled with silica deposits; subsidiary cells parallel-sided; interstomatal cells short.

Transverse section: Outline obtusely triangular (Pl. 9, C). Epidermal cells smooth, see *S. corymbosa*. Hypodermis: outermost sclerenchyma single-layered; inner of 6-8 layers of chlorenchyma frequently associated with tannin idioblasts; sometimes lysigenous air-cavities also present. Brachysclereids absent at the corners. Interfascicular band of 3-4 layered sclerenchyma present (Pl. 9, C). Vb's, bundle sheaths, circumvascular sclerenchyma, see *S. corymbosa*. Vessel members (D. 64-72 μ in diameter). Sclerenchyma girders (Ht. 48-104 μ; W. 64-120 μ), variable. Cells of bundle sheaths and girders containing single cone-shaped silica-body per cell. Metaphloem of ' intermediate ' type.

SHEATH. *Epidermis, surface view:* Cells moderately long, variable; walls very thick, pitted, sinuous; end walls straight; lumina of cells slit like (Pl. 9, E). Stomata (L. 28-32 μ; W. 16 μ); subsidiary cells parallel-sided; interstomatal cells long; stomata often filled with silica material. Silica-cells overlying the costae short, rather broad, thin-walled, found in 3-5 more or less continuous rows, each cell having 1-2 cone-shaped silica-bodies without satellites.

Transverse section: Epidermis, see culm. Ground tissue, see *S. corymbosa*. Air-cavities as many as and regularly alternating with vb's; stellate parenchyma present in the air-cavities (Pl. 9, F). Vb's many, large (type III A) and small bundles (type I), regularly alternating with each other; all forming single row subjacent to abaxial surface (Pl. 9, F). Vessel members (D. 20-24 μ in diameter). Metaphloem, see culm. Tannin idioblasts very common present in the vicinity of vb's (Pl. 9, F). Bundle sheaths double: O.S. parenchymatous, incomplete, I.S. sclerenchymatous, complete. Circumvascular sclerenchyma crescentiform forming an inner cap (Pl. 9, F). Sclerenchyma girders (Ht. 32-40 μ; W. 52-160 μ), crescentiform (Pl. 9, F) and securiform.

MATERIAL EXAMINED: *Ernest Thayasingh 8580*, Pechiparai, Kanyakumari Dt.

Scleria terrestris (L.) Fass.

LEAF. *Abaxial surface:* Intercostal cells variable, moderately thick-walled, sinuous, pitted, broad with straight end walls. Stomata (L. & W. 36-40 μ); subsidiary cells triangular; interstomatal cells short. Silica-cells over the costa long, narrow, thin-walled, smooth occurring in 3-4 continuous rows, each cell containing 1-3 cone-shaped silica-bodies without satellites. Hooks (L. 100-120 μ) marginal, see *S. sumatrensis*.

Adaxial surface: Cells short, broad; walls very thick, pitted, smooth; end walls straight. Silica-cells over the costa rather long, thin-walled, sinuous, narrow occurring in 3-4 discontinuous rows, each cell containing silica-bodies, as described for abaxial surface.

Lamina, transverse section: Outline inversely W-shaped as in *S. corymbosa* (Pl. 8, E). Keel triangular, pointed. Margins obtuse. Epidermal layers overlaid with silica particles. Bulliform cells in regular groups of 7, fan-shaped. Sclerenchyma girders (abaxial: Ht. 20-48 μ; W. 32-80 μ), crescentiform; keel girder (Ht. 100 μ; W. 60-160 μ), triangular; adaxial and marginal sclerenchyma strands (Ht. 60-100 μ; W. 60-160 (-200) μ), pulviniform. Circumvascular sclerenchyma of all the large vb's 2-3-layered, forming inner caps. Mesophyll consisting of 2 layers of palisade and spongy chlorenchyma; chlorenchyma around the vb's radiating. Air-cavities large, regularly alternating with vb's; each air-cavity containing lobed parenchyma. Vb's 62 in number, see *S. corymbosa;* large bundles belonging to type III B, medium bundles to type III A and small bundles to type I; large bundles characterized by protoxylem lacunae. Bundle sheaths double: of large bundles, O.S. incomplete, I.S. complete; of medium and small bundles, both complete.

CULM. *Epidermis, surface view:* Cells long, moderately thick-walled, narrow, conspicuously sinuous with straight end walls; few to many small silica-bodies contained in each cell. Hooks (L. 60-100 μ), see *S. poæformis* (Pl. 10, E). Stomata (L. 44 μ; W. 32 μ), rare; subsidiary cells low dome-

shaped; interstomatal cells long. Silica-cells over the peripheral sclerenchyma girders long, narrow, moderately thick-walled, found in 1-2 discontinuous rows, each cell containing cone-shaped silica-bodies without satellites.

Transverse section: Outline triangular with concave sides as in *S. corymbosa* (Pl. 10, H). Wedge-shaped silica-bodies occur in the sinuosities of epidermal cells. Ground tissue and epidermis, see *S. corymbosa* (Pl. 10, F). Brachysclereids at the corners absent. Hypodermis consisting of 2 layers of sclerenchyma. Vb's, bundle sheaths, circumvascular sclerenchyma, see *S. corymbosa*. Vessel members (D. 52-56 μ in diameter). Sclerenchyma girders (Ht. 32-80 μ; W. 80-160 μ), variable (crescentiform, triangular, rectangular, pulviniform).

SHEATH. *Epidermis, surface view:* Cells short, broad, variable; walls very thick, pitted, conspicuously sinuous. Stomata (L. 36-40 μ; W. 40-44 μ); subsidiary cells triangular; interstomatal cells short; lateral walls of stomata very thick. Silica-cells over the costae long, rather broad, thick-walled, sinuous, present in 2-3 (-4) discontinuous rows, each cell having 2-4 cone-shaped silica-bodies with satellites. Hooks in the intercostal regions (L. 40-52 μ), thick-walled, obtuse, rigid.

Transverse section: Cuticle thick on the abaxial surface. Abaxial epidermal cells thick-walled; the sinuosities of cells containing wedge-shaped silica-bodies; abaxial epidermis overlaid with silica particles. Ground tissue parenchymatous. Air-cavities, see *S. sumatrensis* (Pl. 9, F). Vb's many, comprising large (type III B) and small bundles (type III A) not showing regular alternation but forming single row subjacent to abaxial surface. Vessel members (D. 40 μ in diameter). Metaphloem of ' regular ' type. Circumvascular sclerenchyma 2-6-layered forming inner caps; keel bundles possessing both inner and outer caps. Bundle sheaths double: O.S. parenchymatous, incomplete, I.S. sclerenchymatous, complete. Sclerenchyma strands (Ht. 45-75 μ; W. 120-180 μ), pulviniform; girders (Ht. 45-60 μ; W. 90-165 μ), usually crescentiform.

RHIZOME. *Transverse section:* Diameter of the rhizome examined 9.7 mm. Epidermal cells thin-walled variable. Cortex: outer rather broad, parenchymatous; middle cortex narrow consisting of 4-6 layers of sclerenchyma, each cell of which possessing single cone-shaped silica-body or particles; inner cortex very broad, parenchymatous. Stele delimited by 8-12 layers of sclerotic cells; cells showing simple and ramiform pittings. Cells of the ground tissue containing starch grains. Vb's many, progressively increasing in size towards the centre; peripheral bundles small and forming a ring. Bundle sheaths single, parenchymatous, complete. Vessel members (D. 16-28 μ in diameter).

ROOT. *Transverse section:* Diameter of the root examined 2.3 mm. Exodermis: 1-layered, see *S. corymbosa*. Cortex, central ground tissue,

see *S. corymbosa*. Endodermal cells radially elongated, wedge-shaped possessing lamellated thickenings and oval-shaped lumina. Pericycle sclerenchymatous. Metaxylem vessel members (D. 80-88 μ in diameter). Protoxylem units 10. Metaphloem conspicuous, occurring in 10 units, each unit consisting of 2 large sieve tube elements and 4-5 (-6) companion cells. Tannin idioblasts not observed.

MATERIAL EXAMINED: *Bourne 3100*, Thandigudi, Kodaikanal; *Fyson 1650*, Igoor, Mysore; *Govindarajalu 6535, 6547*, Thekkadi, Kerala state; *Go. 6573, 6602*, Peermede, Kerala state; *Go. 7635, 7647, 7648, 7649*, Panthadikalam, Kanyakumari Dt.; *Go. 9315, 9366, 9451*, High ways, Madurai Dt.; *Sunadaram & Pattabiraman 6803*, Kodaikanal, Madurai Dt.

Scleria tessellata Willd.

LEAF. *Abaxial surface:* Intercostal cells axially elongated, thin-walled, rather broad with straight or oblique end walls. Stomata (L. 36-40 μ; W. 32 μ); subsidiary cells triangular; interstomatal cells long. Silica-cells overlying the costae long, narrow, thin-walled, smooth occurring in 3-4 continuous rows, each cell containing 2-3 (-4) cone-shaped silica-bodies without satellites. Occurrence of calcium oxalate crystals reported by MEHRA and SHARMA (1965) not observed.

Adaxial surface: Cells axially elongated, hexagonal, broad, thick-walled; end walls straight. Stomata (L. 40-44 4; W. 20-24 4); subsidiary cells low dome-shaped; interstomatal cells long. Silica-cells situated over the costae occurring in a single discontinuous row; 5-8 cone-shaped silica-bodies with satellites present in each cell; cells containing silica particles also present.

Lamina, transverse section: Outline inversely W-shaped as in *S. corymbosa* (Pl. 8, E). Keel conspicuous, triangular, pointed. Margins obtuse. Bulliform cells in groups of 11, see *S. corymbosa*. Sclerenchyma strands (adaxial; Ht. 40-80 μ; W. 60-72 μ), pulviniform or rounded; abaxial girders (Ht. 20-40 μ; W. 32-100 μ), crescentiform or rectangular; keel girders (Ht. 40 μ; W. 164 μ), ascendingly crescentiform. Circumvascular sclerenchyma, mesophyll, see *S. corymbosa*. Vb's 29 in number, see *S. corymbosa*. Bundle sheaths single, sclerenchymatous, complete.

CULM. *Epidermis, surface view:* Cells long, thick-walled, pitted with straight end walls. Cells containing conglomerate type of silica-bodies and particulate type of silica materials very common. Occurrence of calcium oxalate crystals reported to be present by MEHRA and SHARMA (1965) not observed. Stomata (L. 44-48 μ; W. 40 μ); subsidiary cells low dome-shaped; interstomatal cells long; stomata commonly filled with and enveloped by silica materials. Silica-cells over the peripheral sclerenchyma girders long, narrow, thick-walled, pitted, found in 1-2 (-3) discontinuous rows, each cell having (3-) 4-6 cone-shaped silica-bodies with satellites.

Transverse section: Outline V-shaped with ribs (Pl. 9, B). Epidermal cells thick-walled. Hypodermis very narrow, consisting of 1-2 layers of cells rendered obscure by tannin idioblasts. Hypodermal brachysclereids absent at the corners. Ground tissue predominantly sclerenchymatous. Central ground tissue consisting of few enlarged parenchyma cells (Pl. 9, B). Vb's arranged almost in two rings; outer ring consisting of large (type III A) and small bundles (type I); large bundles containing protoxylem lacunae. Circumvascular sclerenchyma, metaphloem, see *S. corymbosa.* Vessel members (D. 28-32 μ in diameter). Bundle sheaths, as described for culm. Sclerenchyma girders (Ht. 30-75 μ; W. 60-75 μ), variable (rectangular, crescentiform, pulviniform); sclerenchyma beneath ribs (Ht. 120-150 μ; W. 210-225 μ), dumbel shaped (Pl. 9, B).

SHEATH. *Epidermis, surface view:* Cells moderately long, broad; walls very thick, pitted, see adaxial surface. Stomata (L. 48-52 μ; W. 40 μ); subsidiary cells triangular; interstomatal cells short; stomata thickened all around. Silica-cells over the costae long, narrow, thin-walled, found in 2-3 continuous rows, each cell having (3-) 4-5 cone-shaped silica-bodies with satellites.

Transverse section: Wedge-shaped silica-bodies present in the sinuosities of abaxial epidermal cells. Sclerenchyma girders (Ht. 28-48 μ; W. 80-120 μ), crescentiform and pulviniform. Other details as in *S. corymbosa.*

ROOT. *Transverse section:* Diameter of the root examined 0.5 mm. Exodermal cells variable, 1-layered, see *S. corymbosa.* Cortex: outer cortex, see *S. corymbosa;* inner cortex consisting of 4-5 layers of parenchyma arranged in radial alignment with endodermal cells. Endodermal cells isodiametric with moderately uniform thickening and having broad lumina. Pericycle, see *S. corymbosa.* Metaxylem large, central, solitary. Vessel members (D. 56 μ in diameter). Protoxylem units 7. Metaphloem units 7, each unit containing one large sieve tube element and 3-4 companion cells. Ground tissue parenchymatous.

MATERIAL EXAMINED: *Govindarajalu 6023,* Orukomban, Kerala state; *Go. 6104,* Sholayar, Kerala state; *Sedgwick 2976,* Belgaum.

III. — KEYS

KEY FOR *ELEOCHARIS* BASED ON CHARACTERS VISIBLE IN T.S. CULM

Bundle sheaths double.
  Outer sheath parenchymatous, inner sclerenchymatous.
    Sclerenchyma strands pentagonal.
      Vb's 9 in number, arranged in one ring; air-cavities with diaphragms of lobed parenchyma cells ..... *E. atropurpurea*
      Vb's 46 in number, arranged in two rings; air-cavities with diaphragms of stellate parenchyma cells ..... *E. spiralis*

Sclerenchyma strands inversely securiform.
Vb's 10 in number; air-cavities traversed by diaphragms of lobed parenchyma cells ..... *E. geniculata*
Vb's 11 in number; air-cavities traversed by diaphragms of stellate parenchyma cells ..... *E. tetraquetra*
Sclerenchyma strands triangular; vb's 5 in number..... *E. retroflexa*

Bundle sheaths single.
Sheath sclerenchymatous.
Vb's 60 in number and arranged in two rings; air-cavities peripheral... *E. dulcis*
Vb's 10 in number and arranged in one ring; air-cavities central.. *E. congesta*
Sheath parenchymatous.
Vb's 34 in number and arranged in two systems; air-cavities present throughout ..... *E. acutangula*

KEY FOR *RHYNCHOSPORA* BASED ON CHARACTERS VISIBLE IN T.S. LEAF

Bulliform cells conspicuous, occurring in regular fan-shaped groups.
Median furrow containing only 6-7 cells.
Hypodermal translucent layer of cells present; abaxial sclerenchyma girders crescentiform ..... *R. corymbosa*
Hypodermal translucent layer of cells absent; abaxial sclerenchyma girders pulviniform ..... *R. rubra*
Entire adaxial epidermis 11 cells wide; hypodermal translucent layer absent; abaxial sclerenchyma girders ascending crescentiform..... *R. gracillima*

Bulliform cells not conspicuous.
Bundle sheaths double, O.S. incomplete, I.S. complete; vb's 13 in number ..... *R. rugosa*
Bundle sheaths double, both complete; vb's 43 in number ..... *R. wightiana*

KEY FOR *SCLERIA* BASED ON CHARACTERS VISIBLE IN T.S. AND SURFACE VIEW OF LEAF

Epidermal cells of leaf containing only one type of silica-body.
Interstomatal cells short.
Palisade 1-layered; bulliform cells in groups of 5-7.
Bulliform cells in groups of 7.
Sclerenchyma girders pulviniform ..... *S. levis*
Sclerenchyma girders rectangular.... *S. lithosperma* var. *multispiculata*
Bulliform cells in groups of 5; adaxial girders sub-T-shaped; abaxial crescentiform..... *S. lithosperma* var. *muricata*
Palisade 2-layered; bulliform cells in groups of 7-14.
Bulliform cells in groups of 14; sclerenchyma girders (abaxial) securiform, adaxial (marginal, submarginal) pulviniform .. *S. sumatrensis*
Bulliform cells in groups of 7; sclerenchyma girders crescentiform ..... *S. terrestris*
Interstomatal cells long or moderately long.
Bulliform cells in groups of 9; keel rounded; margins acute; subsidiary cells parallel-sided ..... *S. lithosperma* var. *lithosperma*
Bulliform cells in groups of 11; keel triangular; margins obtuse subsidiary cells triangular ..... *S. tessellata*

Epidermal cells of leaf containing more than one type of silica-body.

Bulliform cells in groups of 13.

Subsidiary cells triangular; vb's 45 in number ..... *S. poæformis*

Subsidiary cells tall dome-shaped; vb's 53 in number..... *S. corymbosa*

Bulliform cells in groups of 5-7.

Bulliform cells in groups of 5; subsidiary cells parallel sided; interstomatal cells with concave ends; vb's 19 in number *S. lithosperma* var. *linearis*

Bulliform cells in groups of 7; subsidiary cells low dome-shaped; interstomatal cells with straight end walls; vb's 13 in number..... *S. caricina*

CONCLUSION

The anatomical structure of the eight South Indian species of *Eleocharis* has been described. Notable interspecific differences have been seen in the internal structural details of the culms. These are sufficiently fixed to be reliable for specific diagnosis. The key characters are those pertaining to the bundle sheaths, sclerenchyma strands, number and arrangement of vascular bundles and diaphragm cells in the air-cavities.

In *Rhynchospora*, besides the occurrence of a certain number of features common to all the species, interspecific differences exist with reference to the presence or absence of hypodermal translucent layer of cells, type of sclerenchyma girders and the nature of the bundle sheaths that are recognizable in the transverse sections of the leaf.

The division of species of *Scleria* into two groups is recognized in the light of type of silica-body in the leaf epidermis; the first groups of species is characterized by the presence of only one type of silica-body and the second by more than one type of silica-body. Further anatomical distinction at the interspecific level is realized on the basis of the size of the interstomatal cells, number of palisade layers, vascular bundles and bulliform cells, type of subsidiary cells and sclerenchyma girders, shape of keel and margin. Separate key for the identification of species under each genus is given.

KEY TO FIGURE LETTERING AND TEXT ABBREVIATIONS

Point at end of paper

Muséum 77898 p. 99
AB.E., abaxial epidermis
A.C., air-cavity
AD.E., adaxial epidermis
A.P., angular prickle
B.C., bulliform cells
B.S., brachysclereid
CHL. or CH., chlorenchyma
CO., cortex
C.P., connecting parenchyma cell
C.S. or C.V.S., circumvascular sclerenchyma
C.S.B., conglomerate type of silica-body
CU., cuticle
D., diaphragm
D.P., dome-shaped papilla
E., epidermis
EN., endodermis
E.P., enlarged parenchyma
F.B., fibre bundle
G., granule
G.C., guard cell
H., hair
H ., hypodermis
I.C., intercellular cavity
I.CO., inner cortex

I.F., interfascicular sclerenchyma
IC.S., intercellular space
I.S., inner sheath
L., lumen
L.P., lobed parenchyma
M.V., metaxylem vessel
N.S.B., nodular silica-body
O.C., outer cortex
O.S., outer sheath
P., pitting
PA., parenchyma
P.D., plasmodesmata
PH., metaphloem
P.L., protoxylem lacuna
PR., prickle
P.X., protoxylem
R., root hair
R.P., radiating parenchyma
S. or SCL., sclerenchyma
SA. or SAT., satellite
S.B., silica-body
S.C., stomatal chamber
S.D., silica deposit
S.G., sclerenchyma girder
S.P., stellate parenchyma
Sl.P., silica particle
S.S., sclerenchyma strand
ST., starch grain
ST.P., stellate parenchyma
T.C., translucent cell
TC.C., tannin containing cell
T.I., tannin idioblast
V.B., vascular bundle
XY., metaxylem
D., diameter
Ht., height
I.S., inner bundle sheath
L., length
O.S., outer bundle sheath
T.S., transverse section
vb., vascular bundle (plural vb's)
W., width

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